POWER PLANT ENGINEERING

CONTENTS FOR THE MONTH OF

SEPTEMBER, 1940
VOLUME 44, NO. 9

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Subscription price $2.00 a year in the United States and Possessions. Canada $2.75 a year. Other countries $3.50 a year. Single copy current issue 25c; back issue 40c.

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PUBLISHED MONTHLY BY TECHNICAL PUBLISHING CO.

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PUBLICATION OFFICE, 53 W. JACKSON BLVD.
CHICAGO, ILLINOIS

ADVERTISING REPRESENTATIVES

CHICAGO: Charles S. Clarke, 53 W. Jackson Blvd., Chicago, Ill.
PHILADELPHIA: H. G. Wilds, 500 W. Clapier St., Philadelphia, Pa.
NEW YORK: John A. Kershaw, Graybar Bldg., New York, N. Y.
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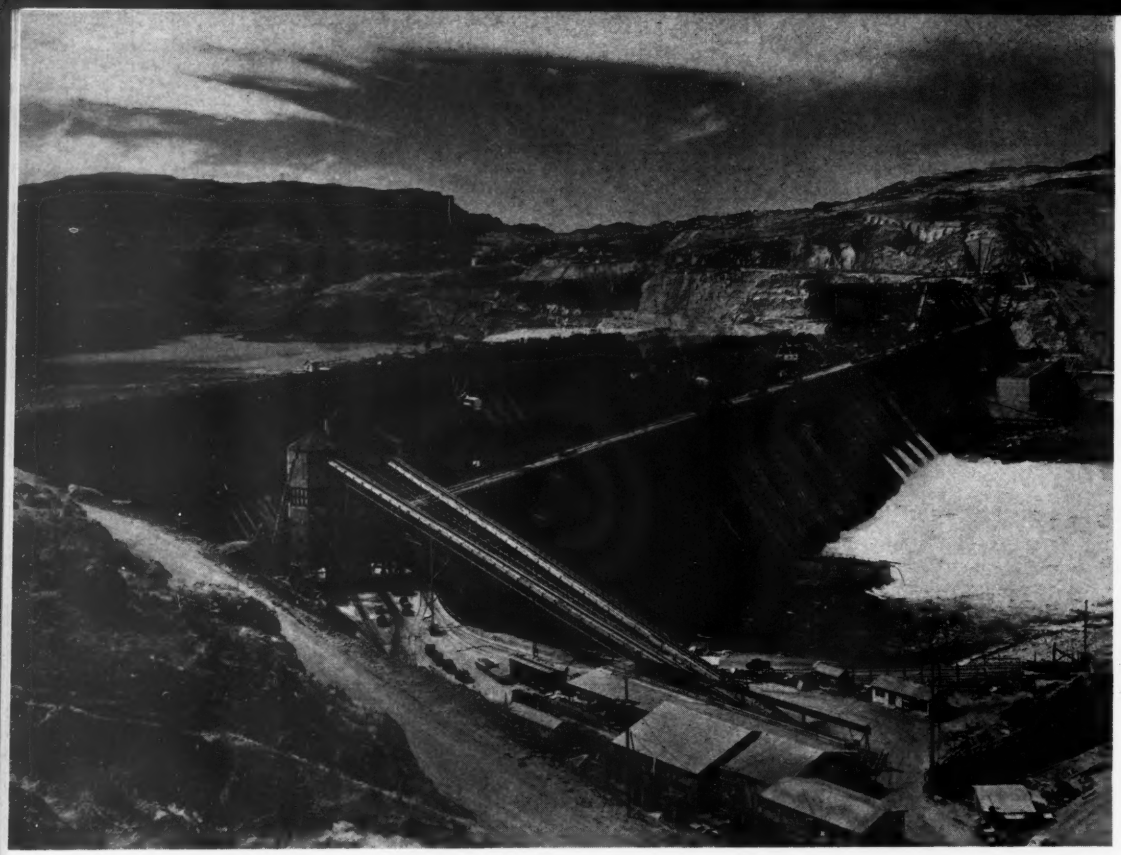


The Biggest Thing On Earth

SEVERAL weeks ago we had the opportunity of visiting Grand Coulee Dam for the first time. Since construction on this great project was started during the winter of 1933-34 we followed it closely through photographs and data released by the Bureau of Reclamation. At various times on this page we presented pictures and wrote "knowingly" about the work being carried out. We felt that we had a rather good conception of its scope and magnitude. Yet, when we stood at the side of the great structure early in August, looked up at its almost mile-long crest and were told something of its dimensions in relation to other objeects, we were utterly amazed—almost bewildered. For nothing we had read nor seen in the pictures had prepared us for the stupendous thing that appeared before our eyes. Grand Coulee Dam, we had known, was the biggest thing man had ever made, it was the most massive structure in the world, larger than the pyramids of Egypt. You may know and believe all these things and go to Grand Coulee with all these facts firmly in mind, yet when you see the structure before your eyes, all the comparisons fade into insignificance. Your first impression, perhaps, is not so startling, everything is on such a huge scale that the size of the structure is not apparent, but when you are told that the central spillway section is over four city blocks long, that the seemingly small hammer-head crane moving along the unfinished crest is 350 ft. wide, that the height of the spillway section is over twice the height of Niagara Falls, that the little power house nestling so far below the crest of the dam is as high as a 15 story building, that what you see of the dam is not all of it—that there is 180 ft. of it below the downstream water level, then, and only then, do you begin to realize the immensity of the thing you are looking at. They will point to a trickle of white water coming through an opening in the face of the dam; that is a solid stream 8 ft. in diameter. The waves below it are 25 ft. high. You can't believe it but you look through your binoculars and then you see it is true. Gradually you become silent—there is nothing to say. No exclamations, no words of surprise or astonishment seem adequate. As the significance of the spectacle gradually develops in your consciousness, all you can do is to look and think and marvel silently at the audacity of man.

WITH THE EDITORS

◆ **THE NEW INDUSTRY . . .** Ever since the collapse of the New Economic Era in 1929, the world has been seeking a new industry, one that will accomplish for today what the railroad, automobile and electricity did for the past. That industry—armaments—has been discovered and for the next few years will dominate the world. Regardless of personal likes or dislikes, opinions or arguments, the die has been cast. Prosperity, which has been lurking around the corner for a decade, turned out to be Mars dressed as a bloody harlequin.

A recent issue of the bulletin of the National City Bank sums up the whole matter concisely from a rational viewpoint that cannot be escaped. The bulletin says: "It is a tragic circumstance that this long hoped for stimulus should come from the manufacturers of weapons of war . . . which, though necessary for protection, add neither to real wealth nor the fulfillment of human wants . . . nevertheless, deplorable as is the diversion of labor and capital to non-productive uses, it must be recognized that the expenditure of vast sums upon armament can create a high speed turnover in business, make jobs and give the appearance of prosperity while the spending lasts."

We can only hope that by the end of this spending period the world will be more settled and can proceed to build an economic system to meet modern conditions, one not predicated on the assumption that 20 per cent of the population must be non-productive, doomed to idleness and public charity.

◆ **FIFTH COLUMNIST . . .** With one thing and another National defense bobs up at every crook and turn. It is even cleverly taken advantage of for exploiting even such a relatively non-essential as a new face cream. "Relatively non-essential" is used advisedly so as to ward off accusations of some irate advertising man that we actually are, or are aiding and abetting "fifth columnists." Last month this rude appellation was bandied about over the statement in the July issue, which placed our domestic airplane capacity for 1939 at 3000 annually. By July 1, 1942, our domestic plane production should be up to 25,000 annually.

◆ **FATHER TIME'S PART . . .** Very enlightening was Mr. Knudsen's statement last month, in direct answer to a question by Senator Lodge about the time needed to completely equip ("guns, tanks, everything") an army of 2,000,000 men, "It seems to me, Senator, that the entire amount could be handled by the middle of 1944—everything." About the same time, early in August, it was brought out that orders had been placed for only 33 out of 4,081 planes for which Congress appropriated approximately 400 million dollars in June. Armament therefore is not a mere matter of money, authorization and congressional approval, for the time element cannot be ignored.

◆ **ASK THE VETERANS . . .** A further measure of this time element is available from experience in the last world war—not under peacetime preparedness but under emergency war conditions, at a time when quantity production was already highly developed and when armament production for European countries was well under way. Following the war, Col. Ayres, then chief of the Statistics Branch of the General staff compiled "The War With Germany" (Government Printing Office 1919) which presents some interesting facts. For quantity production: rifles, 7 mo.; machine guns, 11 mo.; artillery, over a year.

◆ **THE POWER BOTTLENECK . . .** While a national problem, all this belongs here only because of its intimate relation to power capacity and production—power needed first to help make the machine tools and then to turn out armament on top of the normal industrial and domestic needs of the nation. The utility capacity, added last year and contemplated for the future, adds approximately 50 per cent to the 1938 figures but much of this, especially the large hydro capacity, is still several years in the future.

Additional needs of the armament program cannot be estimated but a large share of it will have to be met within a year or two by new steam and Diesel engine capacity. Herein lies the chief danger, inadequate power facilities for the load and direct conflict with the naval needs for prime movers. Turbine and engine factories are already working at capacity with orders for months ahead.

Authorized naval and cargo vessel construction needs are estimated at approximately 5,000,000 hp. by 1942. This will throw a severe burden in prime mover manufactures both turbine and Diesel. Already there is talk and rumors of the necessity for giving consideration to priority for certain orders. While there seems to be some difference of opinions as to just how far present legislation goes in permitting changes in orders already placed and under construction, there is no question that with the present temper of the country any legislation necessary to permit the National Defense Council to carry out its plans would be forthcoming.

◆ **BATTLEWAGONS . . .** Under these conditions, the Naval work would be expedited and undoubtedly the private utilities would also fare well especially in industrial areas. The vital role of power supply has been recognized and has received close study for the past two or three years and the degree of standardization already arrived at will do much to facilitate quick construction. Furthermore, the private utilities industry is well organized and will have adequate representation. Federal construction is already too closely identified with National defense to brook much change.

As a class the municipal utilities are not in such a favorable position and the independent industrial plants are still less favorably situated. Should it come to a showdown, any case in either of these two groups would undoubtedly have to be considered individually with due consideration given to the immediate needs, as affecting the armament program as a whole, and to the length of time involved in previous planning for such need. In a project as comprehensive as this, individual consideration is difficult, unless it should come within the essential requirements of the War Department.

◆ **FINGER OF CONSCIENCE . . .** As long ago as 1938 the N.A.P.E. recognized the fundamental weakness of the individual plant in this connection and offered the assistance of the association in connection with the industrial power survey being considered by the Federal Power Commission. Unfortunately this project was never carried through and only a comparatively small section, the electrochemical industry, was covered. The Census of Manufactures figures in this connection are woefully inadequate and the independent or isolated plant power resources of the nation are still largely an unknown quantity.

Support of organized societies in this connection is important not ony because of the possible influence on appropriation of funds to carry on the work, but because of the emphasis placed on individual plant requirements. The engineer who confines his activities to operating a plant without planning ahead for improvements and mapping out a program for probable expansion is not doing his full duty to himself or his employer. Authorization for changes may be up to the management but this does not relieve him of the responsibility of keeping his plans complete, data up to date, and presenting them periodically backed by definite reasons for the recommendation. Many industrials without such far sighted engineers are due for a sad awakening during the next three or four years.

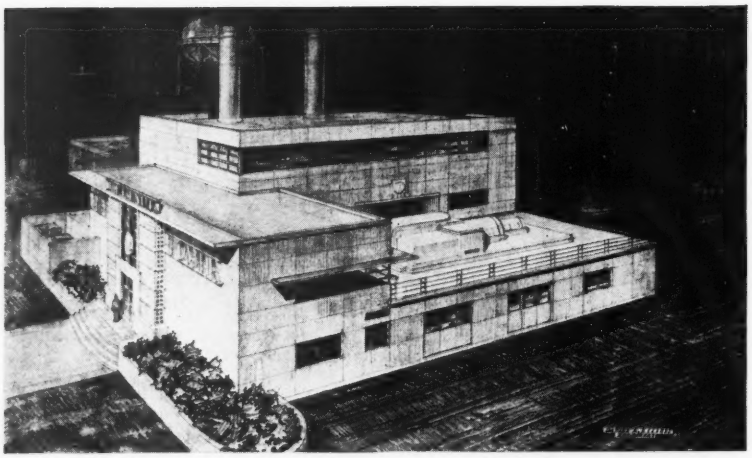


Fig. 1. Architect's sketch of Burbank's new plant on which construction has just been started. It is of semi-outdoor type, making extensive use of glass brick and designed for two 120,000 lb. per hr. boilers and a 625 lb., 825 deg. F., 10,000 kw. turbine. It will operate in parallel with Boulder Dam power, have a full load heat rate of about 13,750 B.t.u. per kw-hr. and put power on the switchboard for about 2½ mills. A 15,000 kw. unit is contemplated in the near future

California Goes Modern

BY FAR the most interesting of the smaller plants now under construction, from both an architectural and engineering standpoint, are the two being built by the neighboring California municipalities of Burbank and Glendale. Both plants are of modernistic design, and make liberal use of glass brick for utility and appearance. The semi-outdoor construction, with the boiler and control panels enclosed and the turbine on an exposed deck, is said to have made a material reduction in superstructure cost.

While the modernistic features add much to the appearance of the plant, it was accomplished at no extra cost by close cooperation of architect and engineer so as to obtain a truly functional design. In this connection it must be remembered that the plants are in the earthquake zone and as such must incorporate the so-called earthquake construction so highly developed in that section, an extreme rigidity of individual parts combined with extreme flexibility of the unit as a whole.

Of equal interest is the fact that both plants will operate in parallel with Boulder Dam power, and initially at least, be carried on the line at minimum load but designed to pick up full load in a matter of seconds. The plants are not considered as standby, however, but were necessitated by the rapid increase in population, and industrial load due primarily to the rapid expansion of the local air-plane industry. Consequently the load, in those districts has rapidly outdistanced the available and allotted Boulder Dam power. With the low fuel costs, steam power can compete with hydro power on a very favorable basis, for while the latter is cheap at the switchboard, transmission costs are high. To an investment of $30-45 in generating capacity must be added about $200 per kw. investment costs in transmission lines.

Burbank

Burbank, for instance, has a 5000 kw. contract with the Government involving some 22,500,000-kw-hr. annually and costing 1.65 mills at the dam. This is, however, subject to revision downward in accordance with the re cent Federal enactment covering Boulder Power rates. Transmission line costs, prorated with Los Angeles and a number of other cities, brings the total cost up to from 5 to 6 mills. With natural gas at 10 ct. per M. cu. ft. and fuel oil at 50 ct. per bbl., it is expected that the steam plant, with a full load heat rate of 13,750-14,000 B.t.u. per kw., will put power on the busses at about 2.5 mills per kw-hr. adequate plant load for good performance is assured for the peak demand has already reached the generating capacity of the first unit.

Initially the Burbank plant will have the 120,000 lb. per hr. B&W boilers with integral furnaces designed for natural gas firing with oil standby. Generating capacity will consist of a 10,000 kw., 625 lb. 825 deg. F. Allis-Chalmers turbine with four points of extraction, set over an Elliott 8000 sq. ft. condenser and driving a 4500 v. generator.

All auxiliaries will be electrically driven and carried on a Terry 750 kw., 2500 v. house turbine. Motors of 75 hp. and over will operate at 2500 v. and below this at 480 v. Condenser water will be cooled in a Marley forced draft tower and it is estimated that 78 deg. F. or cooler water will be available 90 per cent of the time. The heat balance incorporates Struthers-Wells extraction heaters; a Cochrane deaerating heater; a Griscom-Russel single effect evaporator and three boiler feed pumps and one Union triplex reciprocating unit and two Byron Jackson centrifugals. The plant is expected to be in service next March.

J. H. McCambridge is General Superintendent of the Burbank Public Service Dept. and J. B. Johnson is Mechanical Engineer.

Glendale

Glendale's power contract calls for approximately 80,000,000 kw. at the Dam (about 72,000,000 kw. at Glendale) and a transmis-

sion line capacity of about 18,468 kw. which is below the city's 1939 peak of 18,600 kw. The new plant, authorized in 1939, will cost approximately $1,800,000, or about $90 per kw. of capacity for the first unit. This will be considerably reduced when the second unit is installed due to building space, substructure and some auxiliaries which will be incorporated in the initial construction but intended for the second unit.

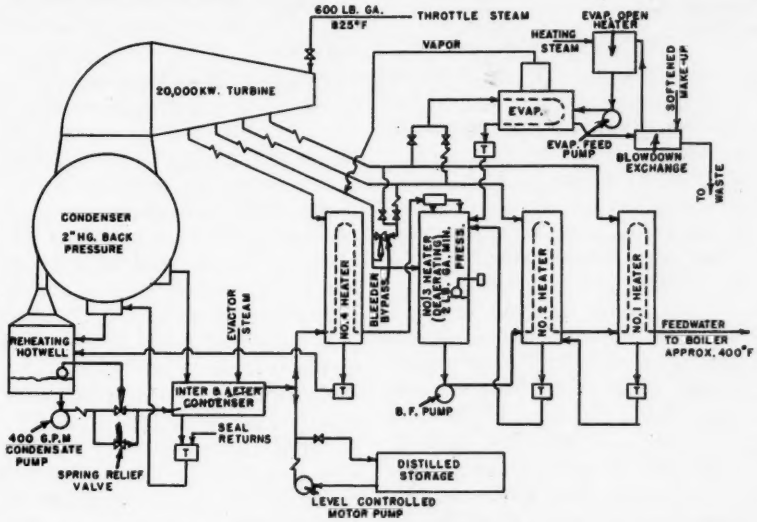


Fig. 2. Flow diagram of the Glendale Station with four stages of extraction heating and a single effect evaporator

Initially, two 200,000 lb. per hr. (280,000 peak) Combustion Engineering gas and oil fired boilers will be installed with space provided for a third. The new turbine with a heat rate of 10,900 B.t.u. at full load and 28 in., is a 20,000 kw. General Electric unit, (designed for overload to 25,000 kw.) with four stages of extraction and driving a 20,000 kw., 0.8 p.f., 13,200 v. hydrogen cooled generator. This will be stepped up to 35,000 volts for transmission to the city's substation and then stepped down to the distribution voltage of 4400. The turbine will exhaust to a 16,000 sq. ft. Ingersoll-Rand condenser with one 7200 and one 19,200 g.p.m. circulating pump. Water will be cooled in two 4 cell induced draft cooling towers, each cell being provided with a six bladed 12 ft. diameter fan driven by a two speed vertical motor.

Normal steam conditions are 600 lb., 825 deg. F., but the turbine is designed for a maximum operating pressure of 725 lb. The higher pressure will be used while the unit is floating on the line at minimum load, so as to take advantage of the accumulator effect due to the drop in pressure when large blocks of power are suddenly thrown on the machine.

Boilers, turbines and auxiliaries have been designed to allow an increase of from 5 per cent to full load in 30 sec. The turbine itself will be installed outdoors with the turbine deck served by a 75 t. Cyclops Gantry crane, itself an excellent example of making presentable a piece of equipment which seldom adds to the attractiveness of a plant.

All auxiliaries will be motor driven, power normally being supplied from a house service transformer bank. During periods of low system frequency a house service interruption the auxiliary load will be carried on a 1500 kw. Terry turbine driving a Crocker Wheeler 2400 v. generator and designed to start in 10 sec. All motors of 50 hp. and over are for 2400 v. operation, below this for 440 v. The heat balance shown by Fig. 2 incorporate Lummus closed heaters, a Griscom-Russell single effect evaporator and a Worthington 400,000 lb. per hr. deaerator. Other auxiliaries include Pacific boiler feed pumps, Ingersoll-Rand condenser auxiliaries, a Worthington air compressor and Quimby fuel oil pumps.

When Peter Diederich, Superintendent of the Glendale Public Service Dept., started to work for the department in 1909, there were 190 customers. Now there are 29,860 meters. In 1916 the water and light departments were merged and Mr. Diederich has been in charge of operations since 1919. O. H. Hedrich, Mechanical Engineer, in charge of design and construction of the new plant, is on leave of absence from a similar position at the Pasadena.[1]

On both the Burbank and Glendale plants Carl A. Heinze was consulting engineer and Daniel A. Elliott consulting architect. Both have offices in Los Angeles and the latter is also architect for the Metropolitan Water District.

[1]Steam Power Plant Development at Pasadena, by Otto H. Hedrich, Mechanical Engineer, Pasadena Municipal Light & Power Dept. Power Plant Engineering, Oct. 1, 1929, p. 1044.

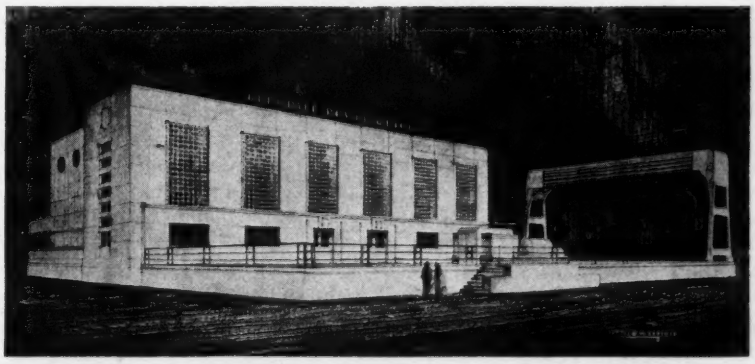


Fig. 3. Construction on the Glendale plant is well along and is expected to be in service shortly after the first of the year. This plant is also of semi-outdoor construction but with the turbine deck serviced by a 75 t. gantry crane. Two 200,000 lb. per hr. boilers and a 600 lb., 825 deg. F., 20,000 kw. turbine will be installed initially with space provided for another boiler and turbine

Maintaining Optimum Boiler Efficiency*

By PARKER A. MOE
Superintendent of Power
International Harvester Co.,
Milwaukee, Wis.

DURING THE YEARS of 1928 and 1929 the Milwaukee Plant of the International Harvester Co. erected a new power plant involving 5 pulverized-coal fired boilers with an aggregate capacity of 300,000 lb. of steam per hr. These units were equipped with air-cooled furnaces, rear water walls, superheaters, economizers, soot blowers, fly ash collectors and a complete set of indicating and recording instruments. This plant has now completed ten years of continuous operation at an average thermal efficiency of 89.39 per cent with a corresponding stack temperature of 281 deg. F.

In addition to the high efficiency obtained, this plant has operated through the ten years without a single shut down. There were no replacements of suspended furnace ashes, or any furnace refractory, except a few door arches and minor repairs, despite the fact that a ten year average of 15.31 per cent CO_2 has been maintained. There have been no tube losses on any boilers, water walls or economizers, nor have we lost a single watt blower element. A few superheater tubes were lost, however.

Although this same efficiency cannot be maintained in every small plant due to the absence of economizers and superheaters, it nevertheless should be remembered that every plant has its own optimum efficiency and should endeavor to achieve that goal.

When this plant was first placed in operation, the first item needing attention was personnel training. Each man was taught his respective duties. This served as a foundation for his future training in becoming as close to a 100 per cent operator as could be expected. Some of the important points directed to their attention were: safety from the standpoint of coal dust explosions, proper regulation of draft, and maintaining the desired CO_2 without smoke. It was important to determine the effects of high CO_2 on furnace temperature, stack temperature and efficiencies, to establish the limits of CO_2 over the entire operating range. Continuous evaporation tests were run on each boiler for several days, and the following data tabulated: CO_2, stack temperature, furnace temperature, draft, carbon loss, radiation loss and efficiency for the entire operating range. The minimum load that we could operate a boiler at without too high a carbon loss and the CO_2 which could be maintained at this light load. Our data revealed that 17 per cent CO_2 could easily be maintained on ratings above 150 per cent. This CO_2 at 150 per cent boiler rating resulted in a mean furnace temperature of 2500 deg. F., and for safe operation required a coal having an ash fusion of 2700 deg. F., or higher. When increasing the boiler rating to 300 per cent and 17 per cent CO_2, the mean furnace temperature was found to be between 2800 and 2900 deg. F. At this temperature the ash would fuse and slag both the furnace refractories and boiler tubes. The refractories would be softened by overheating and would ultimately shorten its life. Therefore it was necessary to find the percentage of CO_2 at 300 per cent boiler rating that would correspond to a mean furnace temperature of 2500 deg. F. Our data revealed that a CO_2 of 13.5 per cent would meet this condition. Likewise, these tests showed that with a coal of 2400 deg. F. ash fusion, the furnace temperature required would be 2200 deg. F., corresponding to a reduction in CO_2 to 16 per cent and 10 per cent respectively.

With all these facts before us, it was concluded that our best operating range was from 125 per cent to 200 per cent boiler rating, with the CO_2 ranging from 16.5 to 15.5 per cent respectively. Higher ratings could be run for short durations or in emergencies, but during such times the top efficiency is sacrificed and the CO_2 reduced to avoid slagging and overheating of the furnace refractories.

With the above information at hand a chart was drawn (Fig. 1) showing the stack temperatures corresponding to the CO_2 and boiler ratings. This chart showed the CO_2 that should be run at the various ratings, ranging from 75 per cent to 300 per cent, and the corresponding test efficiencies. One of these charts is placed under glass on the instrument panel of each steam generator. It provides a definite guide for the operator in the proper operation of the boilers. When a new coal with different characteristics is used, supplementary instructions are set up and the operating chart revised to suit the new coal.

The operators were trained to maintain the operation as indicated on the chart, the chart efficiency being our optimum as revealed during testing operations. When a load change is obvious, his training enables him to add or drop boilers in conformity with the limits revealed by the chart. If he obtained an efficiency corresponding to the chart he was considered a 100 per cent operator. Records were made of the results of each operator, on all shifts, and he was rated accordingly. At the end of the month this record (Fig. 2) is posted, showing the comparative standings of each operator in coal dollars

*Abstract of a paper "Maintaining the Optimum in Steam Generator Efficiency," presented at the Midwest Power Conference, Chicago, Ill., April 9-10, 1940.

gained or lost. The name of the most efficient operator would head the list, creating an incentive for the other operators to strive for better operation. Careful attention was given to the kind of coals used and tests run to determine which coal produced steam at the lowest unit cost. The various coals tested are all run on the same boiler at like ratings; the balance of the boilers burn the test coal to show the results under fluctuating loads.

The same attention is given the feedwater. This is analyzed three times a day and the treatment adjusted accordingly. Very little scale has been encountered.

As a means of minimizing blowdown losses, a continuous circulating blowdown system is used in conjunction with a lime-soda softener. Each boiler has an individual continuous blow discharging into one large blowdown tank, connected in parallel to the softener. The sulfate ratio in the softening tank is maintained by controlling the amount of blowdown water entering the softener.

All flyash and carbon which accumulates in the flyash traps is recirculated through the pulverizers to the furnace and reburned. The system operates automatically, without the use of additional equipment, and has resulted in an almost complete elimination of carbon loss.

From the standpoint of efficiency it is important to keep boilers in service as long as possible. This may be pointed out by the fact that in our case, putting a steam generator on the line requires 5 t. of coal. If it is fired up once in 6 mo., it only reduces our efficiency less than 0.1 of one per cent, while if it is fired up once a month, the efficiency will be reduced 0.55 per cent. Our inspections are at 6 mo. intervals and this in turn governs the length of continuous operation per unit.

When boiler are inspected the entire unit including pulverizer, fans, soot blowers, instruments, valves, safety devices and furnaces are inspected and repaired if necessary. While the boiler is being operated, minor repairs which have accumulated are listed, so they will not be forgotten, and before this boiler can be placed on the line, all of these repairs must be taken care of. With this method of checking over the boilers, they are in a satisfactory condition to operate continuously for 6 mo. All changes and repairs are entered in a permanent record book and referred to when making the next inspection. The condition of repair is then noted to eliminate mistakes and reoccurrence.

A continuous record is kept of the hours each unit is in service. During the course of each year the hours of operation are distributed as equally as possible, so that over several years, each unit has run approximately the same length of time.

A uniform degree of fineness is essential to good operation in pulverized coal. The mill must be kept in good condition and the hammers inspected, balanced, or renewed. The period between inspections is determined by tonnage tests for various type of fuel. In case of carbon showing up in the ash, sieve tests are run to check the fineness, and if found to be unsatisfactory the mills are checked.

A permanent system of periodic inspection of all equipment is the key to avoiding large and expensive breakdowns. We have a large master chart containing over 200 items to be inspected at intervals varying from 1 to 26 weeks, depending on their importance. At the beginning of each week all items to be attended to during that week are dispatched

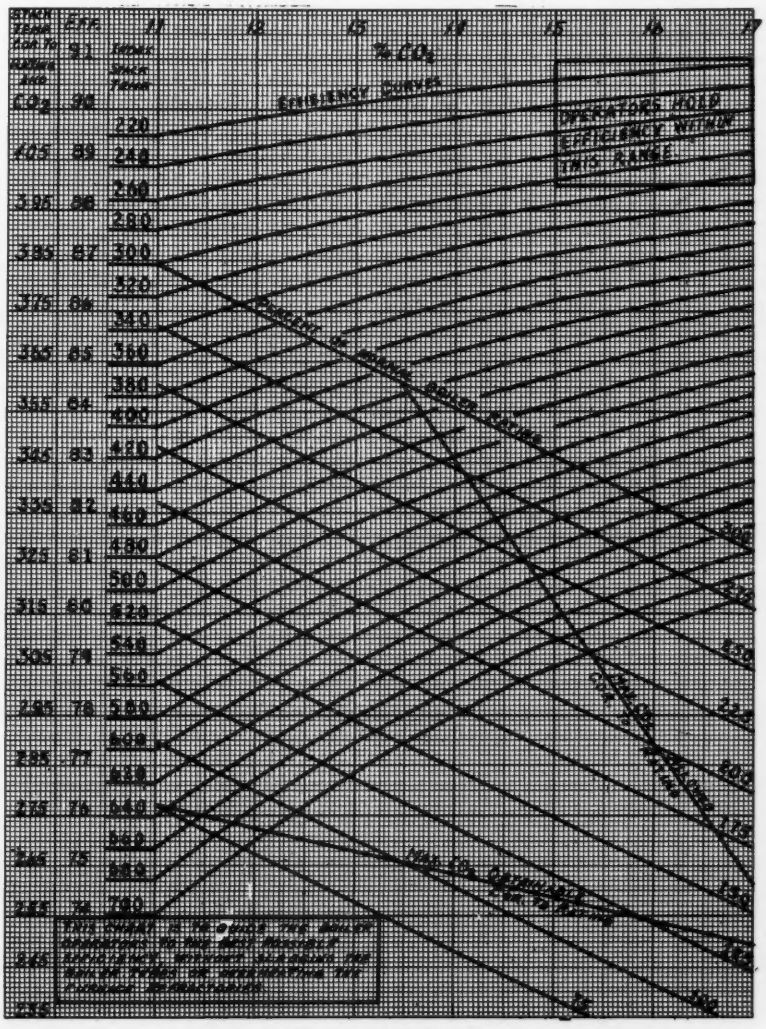


Fig. 1. Most efficient boiler load chart

Gains & Losses in Boiler Operation for the Month of January 1940

Name	Lbs. Steam	% Rating	% CO_2	Rm.&Stack Temp.°F.		Test Eff.%	Actual Eff.%	Loss In $	Gain In $	%Eff. of Operators
A	23,952,600	153	15.82	86	271	90.03	90.00	1.43	0.00	99.97
B	19,518,450	151	15.68	85	271	90.05	89.98	2.73	0.00	99.93
C	19,907,400	153	15.41	88	271	90.03	89.88	5.97	0.00	99.85
D	5,629,500	148	15.27	85	269	90.08	89.92	1.80	0.00	99.84
E	13,981,400	148	15.41	86	274	90.08	89.82	7.27	0.00	99.74
Totals	82,989,350	.....						$19.20	0.00	
Weighted Averages		151	15.58	86	271	90.05	89.93	.....		99.88

Fig. 2. Typical example of chart used to show comparative standings of operators

to the proper men. At the end of the week, all work completed is entered on the master chart for a permanent record. Items unattended to appear in double red checks, on the following week's dispatch sheet. With a system of this nature the regular work may be distributed so that at the end of a given time all the equipment in the plant will have had proper attention. We have found from experience that it is better to thoroughly inspect every piece of equipment over a wide range of time than to try and inspect all of the equipment in general, without giving detail inspection to each part of a unit. As an illustration of this chart put to use we will use our valve inspection. All valves, large and small, are numbered and grouped, each group being inspected every four weeks. This means a few valves are checked daily, but in the course of four weeks they have all had attention. This inspection includes opening and closing the valve the full length of stem travel, lubricating stem and checking the packing. When attended to in this manner they are always in a serviceable condition. Other items included in the inspection schedule are taken care of in a like manner, regardless if the equipment appears to be in good working order or not. The results of these inspections can be brought out by the fact that in over ten years of operation, this plant has not had a single breakdown or the loss of a single major bearing in both of the boiler and engine rooms.

A place card is posted on the front of each steam generator to list any item on the unit that needs attention. It is the duty of the entire personnel to record this information. Each morning these reports are collected and transferred to a monthly master chart, and from there dispatched to the maintenance men. All items remain on the chart until it is taken care of. If for some reason the item could not be attended to during the month reported, it is carried forward to the next month's chart, where it appears in red. By this perpetual check no item escapes attention or is neglected. Definite inspections of the boiler instruments are made at regular intervals.

A complete set of records are kept of all equipment and of the personnel operating the equipment. Thirty curves, which are plotted daily, point out our operation graphically. When a drop in efficiency is noted, it is immediately investigated and corrected. The results of each operator for each unit is recorded and the man or unit responsible for the drop in efficiency can be singled out.

Stack temperatures corresponding to the CO_2 and rating are checked daily. In one instance our stack temperature rose 15 degrees F. An investigation revealed that one of the monolithic baffles had developed a fine crack, which was about the width of a penkife blade. When this crack was repaired the stack temperature returned to normal. Without records and close checkups this 15 degree rise would have been unnoticed, and in the course of time several such cracks may have appeared. This would have caused an unnecessarily high stack temperature, and greatly impaired the efficiency. Complete reports covering boiler heat balances, total costs, and unit costs are determined monthly. We have a Five-Year Chart covering all pertinent information regarding coal, efficiency, CO_2 rating, evaporation and costs. This chart serves as the consummation of all our records and endeavors to maintain the standard which we term our optimum.

The prime requisite of top performance lies in the willingness of the operator in charge to strive to attain the best results out of his equipment, and to maintain it properly and economically. To do this his efforts will be largely confined to establishing standards and training his men to abide by them.

Week Beginning January 7, 1940	1-7	1-14	1-21	1-28	2-4	2-11	2-18	2-
Boiler Room								
Test boilers for air leaks	•				•			
Oil and clean soot blowers	•	•	•	•	•	•	•	
Check boiler safety valves	•	•	•	•	•	•	•	
Check coal lorry scale	•	•	•	•	•	•	•	
Check and clean power cabinets			•				•	
Check instruments on boiler No.1	•				•			
Check steam traps in group No.1	•				•			
Check steam traps in group No.2		•				•		
Check valves in group No.1	•				•			
Check valves in group No.2	•				•			
Check valves in group No.3	•				•			

Note: Each vertical column indicates the work to be done during that week.

Fig. 3. Portion of a power plant inspection schedule

RED TAPE— A Curse or Blessing*

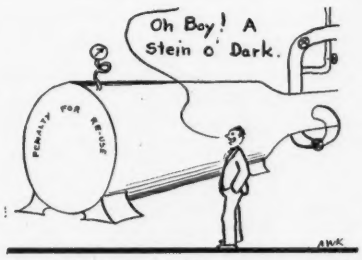
By GEORGE W. DYSON
Consolidated Edison Co.,
New York, N. Y.

CASUAL OBSERVERS who have visited a modern power plant have remarked that a turbine looks like nothing more or less than an oversized beer bottle set in the floor. It must be admitted candidly that a certain aurora of romance disappeared when the reciprocating engine with its gleaming brass fittings, flashing cross heads, ponderous cranks, and gargantuan flywheel was replaced. However, to the trained engineer, it is vastly more exciting to speculate upon the problems inherent in the construction of a 65,000 kw, 1200 psi, 925 deg. F. unit turning over at 3600 r.p.m. He must be a dolt, indeed, whose imagination is not stimulated when he reviews in his mind the problems that engineering has overcome between the installation of Edison's "Jumbo" type generator direct connected to a 125 hp. reciprocating engine running at 350 r.p.m. to the installation of the modern topping turbine.

It is not the purpose of this paper to discuss the "engineering" aspects of engineering, but rather to confine it to the "red tape" aspects. The prediction of load growth and the need for, and the use of work orders has been considered. It is pertinent now to consider a phase of the work which comes under the all inclusive head of "scheduling."

The size and design of our turbo-generator has been determined. The date when good judgment dictates that it shall be available, to pick up its share of the anticipated load growth has been set. It is also known that a turbo-generator complete with the steam generator does not come in one package ready to be shipped into place and bolted down.

A typical turbo-generator will perhaps be manufactured by Westinghouse Company or General Electric Company; the boilers by Combustion Engineering or B & W Company; the superheaters by the Superheater Company; the economizers by Foster-Wheeler; forced and induced draft fans by B. F. Sturtevant. In addition to the major units of equipment that come readily to mind there are the valves, instruments, gages, indicators that are to be supplied by various contractors. In a typical installation over fifty manufacturers made their individual contributions to the completed unit. The situation is further complicated when it is recalled that much of the equipment must be, because of space limitations or design related to other elements existing in the station, to use a common expression, "tailor made" to suit a particular job.



A turbine looks like an oversized beer bottle

We also have the labor problem. If the installation work is to be done by company forces, the work must be coordinated with regular system work to avoid peaks and valleys in the man day curve. If the work is to be awarded to contractors due consideration must be given to the contractor's ability to handle the particular job; the question of bonds and penalty clauses must be taken into consideration.

While the job is in progress, the money invested in equipment is eating its head off, that is, the interest charges are accumulating. It is expedient, therefore, to make the installation period as short as possible.

It can well be imagined what would happen if a philharmonic orchestra attempted to play a symphony without a conductor. Gone would be the nicety of co-ordination which transforms a cacophony of sounds into a well blended and inspired performance. The conductor of any large construction job is the schedule engineer. It is his function to co-ordinate all phases of the work in order that the construction can proceed smoothly, efficiently and without lost motion.

The first problem that faces the schedule engineer is to determine the length of time that will be required to clear the job through his own organization. Once the job has been approved, it is necessary for the engineers to prepare definite drawings and specifications which will cover a particular phase of the job. The Purchasing Department, in turn, requests that manufacturers submit proposals and bids. These proposals are referred back to the engineers who evaluate them and indicate those that are acceptable. The Purchasing Department then awards the contract upon the basis of price, reputation of the concerns and similar consideration.

The next determination that a schedule engineer must make is the time required by the manufacturer to fabricate the material called for in his contract. Stock or standard items do not cause much difficulty, but when the unit is specially made for the job then, to use an expression, "the fun begins." It has to be designed, fabricated and tested. This all requires time and a defective casting, labor trouble or other diabolical action to which inanimate

*This is the second of two articles on the subject by the author. The first appeared on p. 56 of the August issue.

objects are prone can play havoc with a well regulated schedule.

The schedule engineer's worries do not cease with the completion of the unit. As a rule, it must be factory inspected by the utilities' representatives who must be satisfied that the unit measures up to the specifications. Finally the unit must be shipped. Again, the schedule engineer is between the horns of a dilemma. Space is at a premium on a construction job, consequently material cannot be allowed to accumulate. On the other hand, the unit must be available when wanted by the construction forces. This requires a careful study with the Traffic Bureau of shipping dates, and modes of shipment. It also involves a constant check on the progress of construction in order to anticipate material requirements.

The installation of a large unit involves both mechanical and electrical work from foundation to stack. One of the primary tasks of the schedule engineer is to coordinate these two different types of work. This job is particularly important if the mechanical and electrical work are under the jurisdiction of separate supervisors. If the installation does not meet the schedule, the mechanical men can blame the electrical group while, conversely, the electrical group will point with derision to the efforts of the mechanical men. But the schedule engineer can only look in the mirror when he wants to "bawl" some one out.

If the unit is an isolated piece of equipment, the time of installation can readily be estimated. However, labor troubles, adverse weather conditions, requirements of city or insurance inspectors may play a part in throwing the schedule off. Unfortunately the schedule engineer cannot charge, as did the steamship companies of olden days, delays to acts of God. He must foresee possible delays and arrange his schedule accordingly.

But very little equipment installed in a generating station can be termed an isolated unit. As a rule, it works in conjunction with other equipment for which outages must be obtained. For example, work in switch galleries requires that the bus be killed and every safety precaution taken, where the work is to be carried on in proximity to live conductors. All outages have to be arranged with the thought constantly in mind that continuity of service must be maintained. This means that the schedule engineer must take advantage of all routine outages and reduce to a minimum the number of special outages.

The labor problem is always with us

Again, the responsibility of the schedule engineer does not cease when his schedule has been approved. He must follow through on the job as it progresses, checking each item as it is completed with the scheduled completion date. If, at any time, a major upset occurs, the schedule engineer must determine whether it will be necessary to revise the schedule in accordance with the new condition.

It is apparent on the face of it, that no one man can be thoroughly conversant with all the details of construction. He must gather his information from a wide variety of sources; i.e., the engineers, the construction forces, the Purchasing Department, the Traffic Bureau. This calls for diplomatic talents of a high order in order to keep the information flowing smoothly through all channels. Further, the schedule engineer must "speak gently but carry a big stick." If the progress of the job becomes snagged, he must locate the cause and indulge in a little old-fashioned prodding. This causes a little roaring but it is all part of the job.

Obviously, like the work of the load growth expert and the work order specialist, the work of the scheduling force must be classified as "red tape." Although the picture has been drawn in broad strokes and all the multitudinous minor tasks eliminated that fall to his lot, it will be appreciated that the schedule engineer performs a necessary function. We cannot live with him nor can we live without him.

In order to prevent "red tape" from multiplying beyond all earthly needs, it should be reviewed frequently. This review should be conducted by those responsible for its set-up and no more allowed to exist than is justified by necessities. "Red tape," rather than strangling, should support.

Clear Ice Cubes

A NEW USE for condensate was given in a recent bulletin of the NDHA, from the actual experience of a hotel manager using district steam for heating. He had been bothered with the problem of making clear ice cubes for use in the dining room until the central steam district heating representative suggested the use of condensate. This was tried and worked fine, so well in fact that the manager went one step farther and added coloring matter to improve the effect of the crystal clear cubes.

Santee-Cooper Project

IN SOUTH CAROLINA the Santee-Cooper Hydroelectric and Navigation project, which will incorporate the world's largest dam, is about one-third finished and is expected to be completed by the end of 1941. This dam, across the Santee River, is approximately 8 mi. long and consists of concrete, steel and earth fill. The concrete spillway section alone is 3400 ft. long. The Santee River with an average flow of 19,200 cu. ft. per second is one of the largest rivers on the Atlantic seaboard and reaches flood stage at an average of nine times a year. The dam will create a lake of 86,000 a., from which the water will pass through a diversion canal into a second reservoir of 62,000 a. From the second reservoir the water will pass through the power house, then through a second canal to the Cooper River and down to the Atlantic.

Auto Fleets Expense

Discussing this important phase of the utility industry before the S.A.E., the author points out that for every 9 hp. in electric generating plants, the company has a 1 hp. in automotive equipment—a $400,000 business within a business

By RANDOLPH WHITFIELD
Supervisor of Automotive Equipment
Georgia Power Co.

TODAY the automobile fleet is taking its place in size among the major items of operation in a public utility. For instance, in our company, the automotive expense is 80 per cent as large as the electric transmission expense and 20 per cent as large as the company electric distribution expense. Our car and truck fleet is a $400,000 annual business in itself, and its product, mileage, is turned out at a rate equivalent to traveling around the world almost three times each month. Surprising as it may sound, for every nine horsepower our company has in electric generating plants, it has one horsepower in the motors of its cars and trucks.

There are four important trends that are making it necessary to increase the number of vehicles for a utility's ordinary operation: 1. Increase in rural and and suburban customers; 2. Demand of customers for almost instantaneous service; 3. Reduction in the number of hours available for work due to the wage and hour law restrictions; 4. Rapid increase of labor costs, making it imperative to use man power in the most efficient manner.

There is no economy, for example, in having a $180 a month engineer waste a third of his time, or $60 a month, catching rides with salesmen and line crews when he could be furnished a company car for a total actual cost of only $43 per month.

As car and truck operating costs are lowered, it will be found economical to use vehicles in activities where they could not be justified before. In fact, entire new activities will be developed by public utilities that would not be profitable without lower cost transportation. The addition of rural lines sometimes hinge on the cost of transportation in constructing the line and in servicing it after it is built.

The Jerkwater Power Co. may pride itself on having a very low ratio of cars per customer and a correspondingly low transportation cost. The Shock-Proof Power Co., on the other hand, may have a larger proportion of automobiles and a higher transportation cost and be criticized by the "budget jugglers" for its apparent wastefulness. However, the second company actually may have the lowest overall electric operating cost because its manpower is utilized more efficiently through having ample transportation facilities. It would actually have the most economical transportation setup, although the fleet cost figures alone would indicate otherwise.

It is surprising how much the cost per mile goes up with the lowered mileage. Referring to Fig. 1, it will be seen that at our present average of 1200 mi. per vehicle per month, the total cost per mile is 3.6 ct. However, those vehicles operating only 800 mi. per mo. are costing 4.4 ct. per mi., or 22 per cent more. If our entire fleet of cars and pickups averaged only 800 mi. per month, it would cost us $67,000 more per year to cover the same mileage.

Accurate records show that for every fleet there is one make of vehicle that is the most economical under that utility's operating condition. It is generally thought that any one of the Big Three makes of cars is as economical as the other, but actual fleet records show that there is a variation of from 10 to 18 per cent in operating cost between them.

Careful attention to detail has enabled us to use successfully the lowest priced 1½ ton trucks for the majority of our line crews, including those with eight or ten

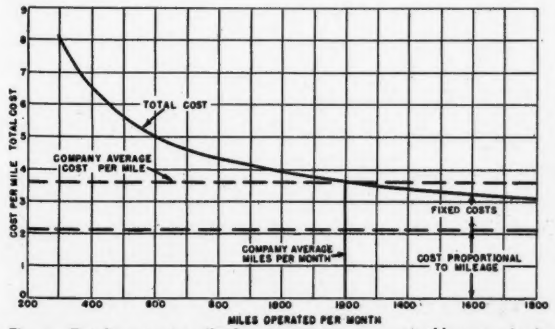


Fig. 1. Total cost per mile for passenger cars and 1½ t. trucks for 1939. Fixed costs include licenses, taxes, insurance, garage overhead, supervision, storage and depreciation. Costs proportional to mileage are shown by Fig. 2

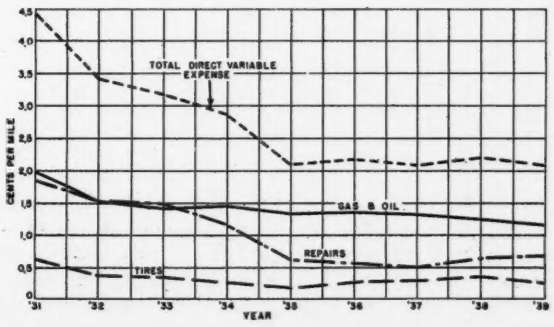


Fig. 2. Direct expense proportional to mileage for the period from 1931 to 1939. Mileage contracts on private cars at 5 ct. per mile are limited to 500 mi. per mo.

men. It has limited our average investment per line truck complete with winch and derrick, to less than $2000. In actual practice we have found that by trading at 50,000 mi. instead of at 75,000 mi. or over, the depreciation cost increased only from around 0.6 to 0.9 ct. per mi., a net difference of 0.3 ct. On the other hand, repair expense alone dropped from about 1.5 ct. per mile to about 0.5, a reduction of 1 ct. per mi. Thus we have a net saving of 0.7 ct., not including the additional savings in tires and fuel expense.

We have tried letting private garages maintain our equipment, but it proved unsatisfactory, both in cost and in equipment condition. As a result, we not only do our own maintenance in headquarter cities, but we have traveling mechanics who spend their time visiting the smaller towns where equipment is located.

Modern Furnace Design

By G. CAMPBELL KOHLAR

"CAN YOU design a boiler for 2000 lb. per sq. in. that will operate on the coal we are now using?"

"I want a boiler that will generate 250,000 lb. per hr. of steam at 1500 lb. pressure."

"Is it economically practical to obtain steam at 1000 deg. F.?"

These are typical of the demands which the larger industrial companies and the utilities are making upon the boiler manufacturers, and it is only a question of time before the operators of the smaller power plants throughout the country will be making similar demands. Why this trend to ever increasing pressure and temperature? Why the large investment in expensive equipment which has hardly emerged from the experimental stage? Why has it been necessary twice within the last decade to revise and extend the steam tables?

The answer is: From steam at high pressure and temperature greater thermal efficiencies can be obtained and cheaper power be produced. Figure 1, a denuded Mollier Diagram, shows why this is so. A Mollier Diagram included in every steam table, is essentially a series of curves plotted with enthalpy (total heat or heat content) and entropy (availability of heat) as co-ordinates. A practical chart has several series of lines, such as lines of constant pressure, temperature, moisture, etc., running rampant; but Fig. 1 shows only the saturation line and the constant pressure line of 0.2 lb. per sq. in. abs.

If steam expands in an ideal turbine, (100 per cent efficient) to about 29.75 "inches of vacuum," it will change state as shown by the lines AB, DE, and GH. These lines also represent the maximum heat which can be extracted from the steam and converted into mechanical energy. GH is larger than DE which is in turn larger than AB, hence, the higher the pressure and temperature, the more heat available for conversion.

But the Mollier Diagram conveys still more interesting information. The enthalpy is represented by the lines AC, DF, and GJ. The solid portion of these lines represent heat available, and the dotted portions, heat which can never be recovered. The ratio of the solid line to the whole line, GH/GJ for example, is the thermal efficiency of the process. Thus, at high pressure and temperature, is it not only possible to convert more heat into work, but also it is possible to convert more of the heat, put into the steam in the boiler, into work. The thermal efficiency rises with the temperature and pressure. Of course, there are no ideal turbines, and the actual process would be indicated by lines curving to the right of those shown in the figure and terminating at a somewhat greater enthalpy, but the principle involved is no different.

The Man to Blame

All this has been common knowledge for many years; but the metallurgist couldn't produce metals which would stand up, the manufacturer didn't know how to fabricate such a unit even if he had had the proper materials, and the designer hadn't the least idea of how the desired results might be obtained in the first place. As advances were made in one of these component arts, the others took up the challenge, carried the development a little farther, and then created a new problem for the party of the first part to solve. Eventually, it became evident that boilers could be built for high pressures and temperatures, and that turbines could be built to utilize steam at these conditions. It was then realized that beyond a certain point, roughly 800 lb. pressure and 850 deg. F. total temperature, conventional designs of boilers like the cross drum, sectional header type, and the three and four drum bent tube types would have to be greatly modified or even altogether abandoned.

The need for a new design is shown by Fig. 2, which indicates the general trend of gas, steam, and water temperatures as the operating pressure is increased. For reasons which will be discussed later, the temperature of the gases entering the superheater must be restricted to about 2000 deg. F. As the steam temperature and pressure rises, an increasing proportion of the heat of combustion is absorbed in the superheater until a point is reached where the temperature of the gases leaving the superheater is lower than the steam temperature and the superheater actually is heating the flue gases. However, long before this point is reached the mean temperature difference between the gas and steam becomes so small that the transfer of heat from gas to steam is almost negligible.

After the gas leaves the super-

*A previous article dealing primarily with small furnaces for the generation of up to 100,000 lb. of steam per hr. appeared on page 45 of the March 1940 issue under the title "It's Your Furnace." The second part of the present article will deal with slag, its formation and control, the part it plays in boiler design and a word as to probable future trends.

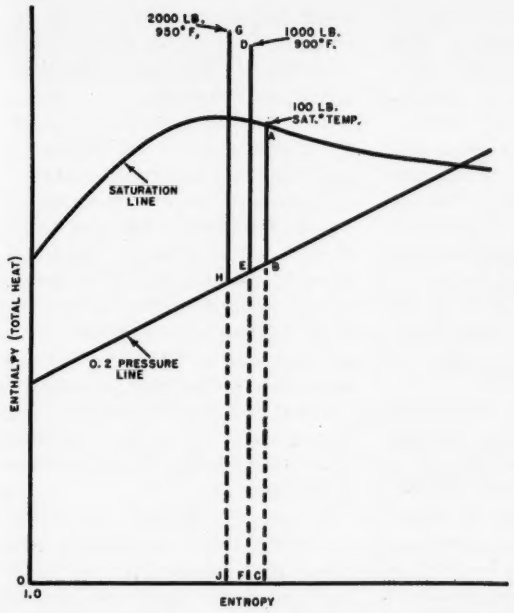


Fig. 1. A simple Mollier Diagram shows effectively why high pressures and temperatures are advantageous

heater in the conventional types of boilers, it passes over boiler tubes until its temperature is so reduced that it can no longer economically evaporate water. The gas is then passed through a different type of heat exchanger, either an economizer, or an air heater, or both. If 600 deg. F. is an economical temperature for combustion gases to enter an air heater, Figure 2 shows that very little, if any, boiler surface will be useful after the superheater when the pressure approaches 1000 lb. Above 1500 lb. the saturation temperature is actually higher than 600 deg. F.

New Problems—New Boilers

By attempting to overcome these difficulties, and the new problems which occurred as fast as the previous ones were overcome, an entirely new type of boiler was evolved. In order to get the necessary temperature of gas to the superheater, fewer boiler tubes were used on the furnace side. The extreme heat of the furnace caused coatings of slag to form on these tubes to such an extent that little gas could get through. The furnace was then made larger to provide a cooler zone around the generating tubes so that slag would not adhere to them so tenaciously. To further protect the boiler tubes, the furnace slag screen was introduced.

But now the gases entering the superheater were too cold, so the generating tubes were removed entirely and the water was evaporated in the furnace walls. The superheater was protected from the devestating heat of the turbulent burners by building the furnace in two stages, the hot primary zone being placed around the corner from the superheater. The temperature of the gas leaving the superheater was too low to evaporate water and too high to put through an air heater, so the space between the superheater and the air heater inlet was filled with economizer.

The furnace is different from the furnace of an orthodox type of boiler. Its functions are many and varied, and they are of the utmost importance. The furnace does not merely serve as a combustion chamber; it converts the ash into readily disposable slag, generates all, or nearly all, the steam, and controls the temperature of the gases to the superheater. Besides, in order for the unit to operate at or near maximum capacity for long periods, the furnace must be largely self-cleaning; that is, the relation between the gas temperatures and the ash characteristics must be such that any slag or ash deposited on the walls will find its way back to the ash hoppers or slag tap floor without the aid of sootblowers, deslaggers, or hand lancing.

Only a very small portion of the ash in the coal must be permitted to travel through the superheater and on to the stack, for ash accumulations in the superheater decrease the rate of heat transfer, increase draft loss, and make frequent shutdowns for cleaning necessary. Thus, the furnace must be carefully proportioned, and many seemingly minor details must be paid close attention.

Until quite recently, the art of building a high-pressure, high-duty steam generator was poorly understood. Quite a few such units have been built with only indifferent success. E. G. Bailey, in a paper entitled "Modern Boiler Furnaces" presented before the 1938 annual meeting of the A.S.M.E. states:

"The greatest single difficulty to overcome in accomplishing all this is the ash in the coal being burned. Not so much ash as such, but ash converted into slag through high temperature combustion; slag that is inevitable, even from the lowest possible combustion temperature when using many of the low-fusing-ash coals which are available today. Ash constitute the main problem; ash in the form of molten slag, plastic slag, sticky slag, sponge ash, and fly ash." In all probability, the greatest single contribution to an adequate understanding and workable solution of the problem has been Mr. Bailey's own researches into the nature of slag and ash.

The Mechanics of Fuel Burning

It might be well at this point in the problem of furnace design, to examine briefly the mechanics of fuel burning. Coal ash is a complex material. It is a mixture of a number of substances, each having its individual physical and chemical properties, and the behavior of the ash as a whole depends upon the interrelation of its various components. If a sample of coal is slowly burned out, the residual ash may be collected and pressed into a cone.

This cone, when placed in a muffle furnace will gradually distort and finally liquefy as the temperature increases. The point at which the apex of the test cone begins to distort is reported as the initial deformation temperature;

that at which the apex bends over at right angles to the axis is the ash fusing temperature; and that at which the cone liquefies is the ash liquid temperature. It is this range, rather than any particular point which is important.

As the coal burns, it undergoes many transformations. In the intense heat of the burner zone complete combustion occurs and the coal becomes gas and ash. The ash particles which come in contact with the walls of this portion of the furnace are usually quite liquid. As the gas rushes on to the stack, becoming cooler as it progresses, the nature of the ash deposits change to plastic, then to sticky, to sponge ash, and finally to fine gray-white dust. It is important to know where these various transformations take place so that provision may be made for handling them.

The zone immediately above and below the burner level in a furnace is hot enough to fuse any ash. Molten slag will deposit on the walls in this zone, thus insulating them to a certain extent and decreasing the heat absorption of them. If this burner zone is cleaned mechanically, the furnace may be too cold for stable ignition and the rate of heat absorption may be high enough to endanger the wall tubes if the feedwater is not perfect.

If the slag is allowed to accumulate, it will build out to some equilibrium thickness, and any succeeding accumulations will melt and run off. The temperature will increase, and the slag will creep upward to the boiler tubes and downward to the floor. If the ash is to be removed dry, this slag will cause serious difficulty in the hopper; but if the slag is to be tapped off in the liquid state, the pool on the flat floor will further increase the temperature in this zone and the slag will run freely from the walls.

The Slag Screen

In the upper section of the furnace, the slag must be removed by some cleaning device; otherwise the temperature to the boiler tubes and superheater would build up dangerously, and slag deposits would plug these tube banks, increasing the draft loss and decreasing the heat absorption. This creeping of the slag, however is inhibited by the use of a furnace slag screen. Under any circumstances, a definite minimum slag belt will exist in the burner zone which can not and should not be eliminated.

If a screen of tubes on fairly wide spacing be placed across the furnace at the upper limit of this slag belt, it will accomplish two results: any fused or molten ash which comes in contact with the screen will stick, and eventually melt and drip down into the slag pool; any ash particles which do get by the screen will be shielded from the radiant heat of the burner zone and, being much cooler than they ordinarily would be, will be deposited as either sponge ash or dry dust, formations which may be cleaned with comparative ease.

This idea is carried a step farther in the two-stage furnace which is built in the form of an L. A relatively small primary furnace with a slag top floor forms the horizontal leg and is separated from a much larger secondary furnace by a slag screen. The heat released in the primary furnace may be 80,000 B.t.u. per cu. ft. per hr., or even higher.

Slag is in a plastic or molten stage, and oozes down the walls to the floor in a continuous stream. It may be tapped off readily, either periodically or continuously. The secondary furnace being much larger than the primary and shielded from it by the screen, is considerably cooler; and as the gases reach the top of the furnace and enter the generating bank, the temperature is low enough to prevent slag formation, and yet high enough to generate the required temperature in the superheater. It must be admitted though, that in the lower section of the secondary furnace the slag does at times become troublesome, and measures must be taken to keep the walls clean in order to prevent the slag from spreading. However, if the unit is properly proportioned, that is not a serious difficulty.

Slag

By this time it is probably quite clear that in the production of high - pressure, high - temperature steam with coal for fuel that the formation of slag is inevitable; and since the slag can be neither eliminated nor ignored, it must be tricked into actually doing something useful. As previously described, the ash in the coal is a heterogeneous mixture of chemical compounds each of which has its individual characteristics. The range over which this ash fuses, and particularly the liquid temperature, is of great importance.

If the temperatures at which the various forms of slag occur are known, the furnace can be proportioned in such fashion that each type of slag can be confined to a definite section and more or

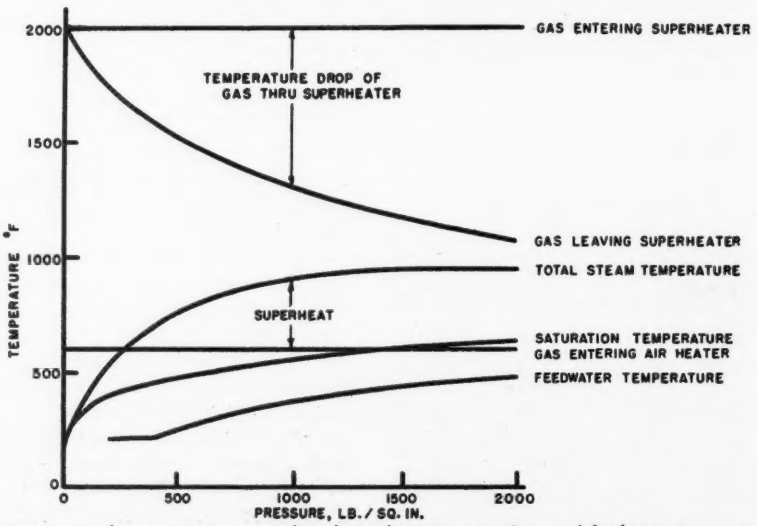


Fig. 2. As the pressure increases the relation between gas, steam and feedwater temperatures increase greatly.

less controlled. The formations depend upon the heat transferred in the furnace, and furnace heat transfer is primarily a matter of radiation. Therein lies the chief difficulty.

Radiant heat transfer is a function of numerous variables which are all either difficult or impossible to determine. But it is possible to measure the temperature of the gases at various points through the furnace, and by making some simplifying assumptions, the much abused Stefan-Boltzmann Law can be applied to obtain a somewhat artificial wall temperature. Artificial or not, this wall temperature is significant. Samples of slag have been taken from different sections of the furnace and their fusion range determined in the laboratory. It has been found that a very definite relationship exists between these fusion ranges and the calculated wall temperatures. By plotting fusion temperature and wall temperature against the square feet of heating surface, valuable information for the proper design of a furnace can be obtained.

Adiabatic flame temperature, that is, the temperature which would be reached if the fuel were burned with no excess air and no transfer of heat to its surroundings, is the highest possible radiating temperature. The temperature in the primary furnace approaches this maximum quite closely. The quantity of heat transferred by radiation depends upon the difference of the fourth powers of the radiating temperature and the receiving surface temperature; and since the upper temperature is practically fixed, the heat transfer in a furnace will vary with the temperature of the walls. The walls are covered with molten slag which is at the liquefying temperature of the ash, and the lower this temperature the greater the heat transfer per square foot of furnace wall will be. The ash in the coal to be burned is thus an important factor in determining the size and effectiveness of a furnace.

Design Procedure

The actual design of a large unit of this type is not radically different from that of the small units described in a previous article. The first step is to determine the minimum width of unit for the desired steam output, since even on these large generators the drum is a principal item of cost. It has been learned from experience that the heat input per foot of width is the limiting factor in setting minimum width. The length of the drum being set, the temperature of the gases entering the superheater must be determined. This will depend upon the steam temperature and pressure, and the range of superheat control which may be required.

Thirty per cent control, for example, would mean that the unit must be capable of producing steam at design temperature and pressure from 70 per cent load to full load. In this case, the temperature of the gases entering the superheater at 70 per cent load would then be proportioned by "cut and dry" methods, using all available information regarding slag formation, etc., until the proper surface is determined. Ordinarily, as the load increases the steam temperature increases, and in order to keep the steam temperature constant, some means of control must be provided.

The most common way of accomplishing this at the present time is by diverting a definite amount of the gas around the superheater—the by-pass method. The remaining problems such as tube metal temperature, size of economizer and air heater, are no different from those of the smaller units except that since the temperature and pressure conditions are rapidly approaching the safe limits, more care and attention must be given to details.

It is the writer's opinion that the trend of boiler design from now on will be largely one of refinement and consolidation of the newer types. Much remains to be learned about many things, fuels, metals, economics, and a host of others. But it is not entirely beyond the range of probability that the next decade or so will find many little brothers of these "freak monsters" installed in the smaller industrial plants throughout the country.

Work Schedules

By E. W. ROBINSON*
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Southwestern Public Service Co.
Amarillo, Tex.

WORKING SCHEDULES for engineers working 40 hr. per wk. has been solved, at least to our satisfaction, by the schedule as shown on a 6 wk. basis. A complete revolution requires 42 da., at the end of which time the cycle begins again. Shifts are rotated so that each man works 10 da. consecutively and is off 4 da. consecutively between each change of shift.

At first glance one might say this is not a 40 hr. schedule as each man works 10 consecutive days. We get around this objection by the simple expedient of splitting each 10 da. period at the end of five working days and calling the sixth day the first working day of the next period.

For example, A starts on a Monday and works 10 da., ending his shift on a Wednesday. We consider A's week to start on a Saturday. Then, in any seven consecutive days starting on a Saturday he will work only 5 da. Likewise, C's week starts on a Tuesday, B's week starts on a Monday, etc.

This schedule has the following merits: rotation of shifts; each man gets four consecutive days off duty; intervals between shift rotation are neither too short nor too long; each man gets the same days off between each shift

*This was written in answer to J. M's. question "Wanted—a Work Schedule" published on p. 542 of the October, 1939, issue. In addition to those already published, replies have been received from M. J. Werdung, G. W. Redman, Chester Wolf, A. Fenton, C. Brooks Hudson, Francis M. Newell, Clinton Miller, Albert W. MacFarland, August J. Ludwig, J. R. Harley, Joseph J. De Maio and Jos. L. Goodwin, and will be published as opportunity permits.

change, for A is off TFSS, B has SSMT off, etc.

Naturally certain day groups are preferred, as TFSS and SSMT, for these groups run over a week end. In setting up the schedule we gave the preferred days off to the operators according to seniority. Some time in the future we may find it advisable to "exchange letters" with certain operators in order to make the distribution of the preferred days off more equitable. At this time, however, the men are all satisfied to abide by seniority.

You will note this schedule is set up for a "three department" plant. We have on duty at any one time one turbine operator, one boiler operator, and one pump operator. Also, we change shifts at 7:00 AM, 3:00 PM, and 11:00 PM, to allow time for the operators to change meter charts and record meter readings at midnight. For plants operating with two, four, or any number of "operating" departments a circular chart schedule of 42 da. can be set up to provide any type schedule required.

This schedule requires several swing men, i.e., men who work part of their period in one department, and the remainder in another. E works 2 da. as a turbine operator, and 8 da. as a boiler operator. Likewise, M works 6 da. as a pump operator, and 4 da. as a member of the maintenance crew.

An interesting relation between days per week worked per man and the number of men required was observed while evolving the circular chart. In the case of a three department plant, the number of men required to satisfy the schedule is equal to 63 divided by the days per week each man works, using 8 hr. as a working day. If each man works 5 da. per week, then the number of men required equals 63 divided by 5, or 12.6 men. This means 13 men must be employed with one man working 0.6 of his time as an operator, and working the remainder, or 0.4, in another department, perhaps the maintenance or repair division. If each man works 42 hr. per wk., then the number of men required equals 63 divided by 5.25, or 12 men exactly.

If the plant is operating on a two department basis, the number of men required to satisfy a 40 hr. schedule equals 42 divided by 5, or 8.4 men. Here nine men would be employed, with one man operating 0.4 of his time and spending the remainder, or 0.6, with the maintenance or repair crew. A 42 hr. work schedule would employ 8 men exactly.

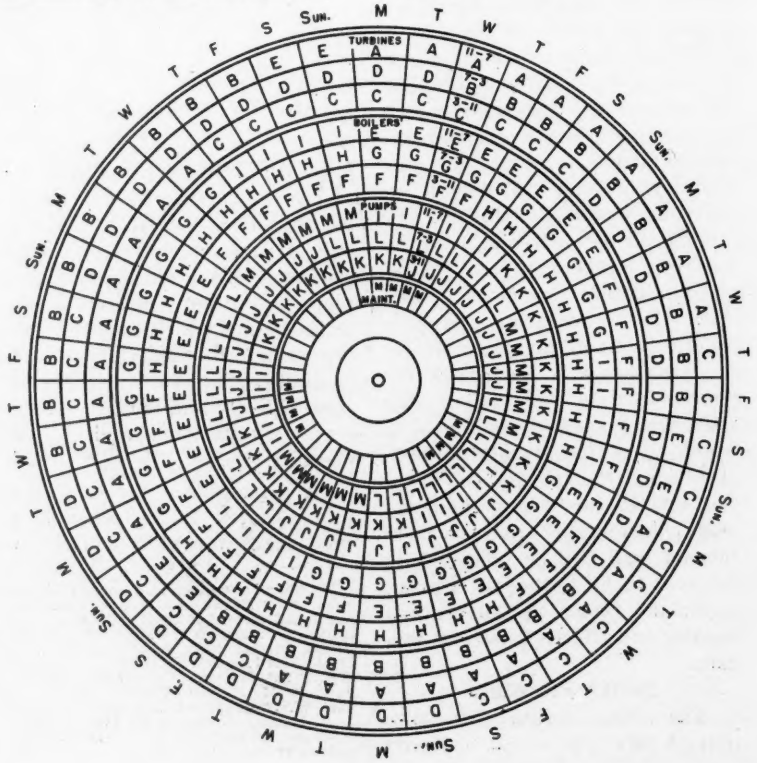
In the case of a "four department" plant the constant becomes 84, which when divided by the number of days worked per week per man indicates the number of men required to satisfy the schedule. A 40-hr. schedule would require 84/5 or 16.8 men. Here 17 men would be employed, with one man operating 0.8 of his time, and spending the remaining 0.2 with the maintenance department. Likewise a 42 hr. week would employ 84/5.25 or 16 men exactly.

Although the law at present permits a 42 hr. schedule we have found such a work week too complicated to be practicable. The 42 hr. schedule introduces "split shifts," which is an objectionable feature from every standpoint. We have, therefore, adopted the 40 hr. work week as being most satisfactory to all concerned.

In setting up a 40 hr. schedule in which the operators are on duty 10 consecutive da., and off 4 consecutive da., it is important, from the standpoint of complying with the law, to set a definite day for each man on which his particular working week is to start, and to adhere to that day throughout. Thus, A's week is to start, always, on a Saturday, and C's week is always to start on a Tuesday.

Of course, a 40 hr. week schedule in which each operator is on duty 5 da. and off 2 da. between shift changes may easily be constructed on the circular chart, but rotation of shifts at the end of every 7 da. is believed to be disturbing to operators. When the period between rotation is as short as 7 da., the men do not have sufficient time to adjust themselves to the new routine of eating and sleeping involved in each shift change.

As actually used in our plant, the chart has the added refinement of a circular perpetual calendar encircling the chart schedule. This enables any man to determine immediately any date in the future on which he will be on or off duty, and is particularly helpful in planning vacations.



Power Plant Operation Problems

The operation of a steam plant presents many problems to the operator. Most of these problems can be solved but the solutions are not always easy and often demand considerable ingenuity. In this article the author takes up a number of specific problems which arose in the plant at Fort Collins, Colorado, and shows how they were solved. This is the first of two articles on this subject by Mr. Crain. The second will appear in a subsequent issue.

By RICHARD W. CRAIN
Instructor in Mechanical Engineering
University of Washington

THE OPERATION of a steam power plant presents many problems to the engineer or operator. Most of these problems can be solved, some not without difficulty, however. It is the purpose of this article to take up some specific cases and explain how the difficulties can be overcome. Other features and improvements in operation that are interesting and helpful are likewise dealt with in an attempt to show how a modern power plant is meeting the problem of efficient operation and successful maintenance. This plant which is that at Fort Collins, Colorado, supplies light and power for the entire city of 16,000 people.

The boilers are Combustion Engineering Co., Stirling type boilers employing Detroit Roto Stokers spreading coal onto a flat grate. Although these stokers can be adjusted to throw the coal more to the rear or the front of the furnace as desired, there was a marked tendency for the coal to pile up against the water back at the rear of the furnace. The reason for this trouble was finally found to be the lack of enough air back there to burn the coal fast enough before it could pile up. There was a distance of 4 in. to 6 in. between the end of the grates and the water back. This space, for the width of the furnace, was just solid floor. Whereas the rest of the floor surface in the furnace, that is the grates themselves, is amply supplied with air passages, the space in question along the back wall had no air passages at all

Consequently, then, the coal that fell upon this blank floor area received insufficient air to burn thoroughly. Thus more and more coal in falling there kept piling up and not burning. This presented quite a problem, too, when dumping the grates. It was necessary to dig into the pile and rake it off into the ash pit at the time of cleaning the fire. Besides this inconvenience, there was the loss of unburned coal which could become quite an item.

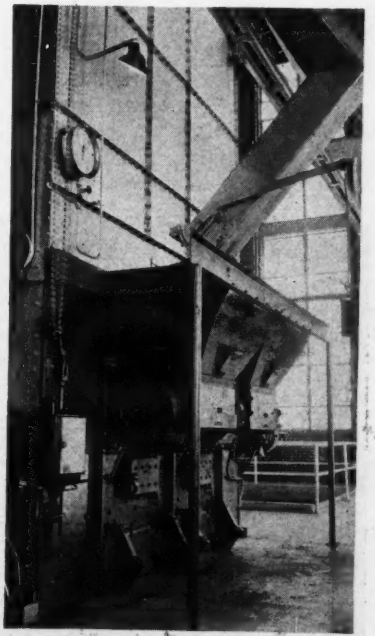


Fig. 1. View in boiler room showing the automatic coal regulator

The way this situation was remedied is interesting. That part of the furnace floor causing trouble was removed. In its stead was placed a flat steel plate drilled with many small holes for air passage. A duct for air was led to the space underneath this plate from one of the plenum chambers under the main grate. The plenum chambers receive air from the forced draft fan. With this arrangement coal falling back against the water back will burn thoroughly and will not pile up to cause trouble or waste coal. Fig. 2 shows views of this improvement in the grates.

This modern steam plant is fully automatic. There are times when the different regulators must be taken out of operation for adjusting or repairing. Whenever this was necessary in the case of the coal regulator, that particular boiler had to be put on hand control. The amount of coal going into the furnace had to be regulated by hand in order to hold the steam pressure constant. This is a difficult job, especially when the plant is pulling a high load, and with a 410 lb. per sq. in. boiler rated at 30,000 lb. of steam per hr.

There are two such boilers and, of course, two sets of coal regulators. These are Smoot regulators operated by means of compressed air in conjunction with oil pressure and a leather diaphragm from a master control on the back of the boiler panel. In order to eliminate the necessity of hand firing when working on the coal regulator, the regulators of the two boilers were interconnected so the one regulator could operate the coal distribution of the boiler whose regulator was out of service.

This interconnection was accomplished by means of an overhead pipe between the boilers. Each end of the pipe was then attached to the coal regulator plunger rod on each boiler through a linkage that is detachable. When it becomes necessary for the opposite regulator to work the coal distribution, this linkage is merely connected

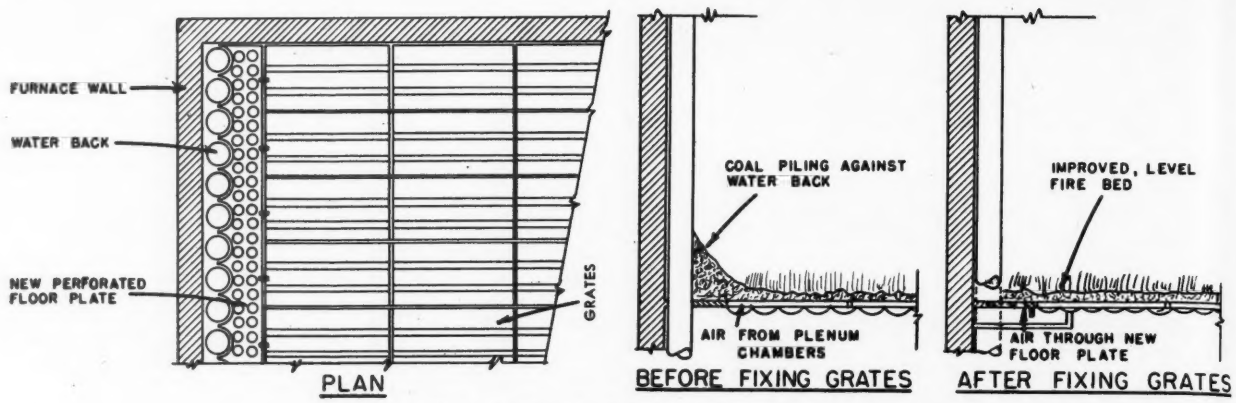


Fig. 2. Plan and sections showing how the grates were improved

onto the cross pipe which is likewise connected in on the other end. Then the regulator out of service can be worked on and still the stoker and boiler continues on automatic operation. This setup works very satisfactorily and gives a much smoother operation curve. Fig. 1 shows the coal regulator.

An Automatic Coal Feed

Coal for the Roto-stokers is conveyed to the bunkers over each stoker by means of a traveling weigh-larry. As the larry is emptied it is run electrically on an overhead track to the end of the firing aisle and receives another ton of coal from the large storage bin. After arriving back at the stoker, the larry gate is opened and the coal allowed to run into the stoker bins. The bins for each boiler are made into two sections, each section supplying a separate rotor. Consequently, it was necessary to run the larry back and forth by hand to level off the coal in each section of the stoker bin. Usually the bins were quite low in coal at this time and the rush of coal into them caused some dust. The larry had to be run by hand to keep each section of the bin full, and it was left each time either over one section or between the two. In either case the coal was uneven in each section making a decided difference in the feeding of the coal upon the grates. This caused the fire upon the grates to change continually in intensity and consistency. The larry often emptied itself without immediate detection by the fireman and sometimes the stoker bin almost entirely emptied before it was replenished. This also affected the burning on the grates and made it quite dusty at times around the stoker.

The resulting inconvenience led to the design and installation of an automatic back and forth feed for the larry above the stoker bins with a bell alarm hooked up through a telechron clock for warning the fireman as the larry runs out of coal. When the coal runs out in the larry, the level of coal in the bunkers lowers until an electric eye is energized by a flashlight across the bin from the eye. This mechanism rings the alarm, a bell, and the telechron clock lets it ring for 10 seconds. If the circuit is not broken by more coal filling the bin, in six minutes the clock will ring the bell again. With these parts plus a motor and clutch hooked up through a magnetic coil, with necessary reverse stops, the weigh larry becomes an automatic coal feeder keeping the two bins sections brimful.

Figures 3 and 4 show a picture and diagram of this set-up for automatically feeding the coal. A switch on the frame of the larry below the larry bin turns the automatic apparatus on and off since it must be disconnected during the regular operation in moving the larry down the aisle to get another load of coal. When the automatic unit is brought in, a magnetic coil is energized which sends a current through a line into a forward and reversing trip switch which is operated by a catch on the side of the larry track. When the switch is on either way, the current drives a small motor which is connected through a train of gears to a shaft in line with the main larry motor. This shaft is then engaged with the main motor shaft by means of a friction disc clutch arrangement. The main motor is thereby driven, having no current through it whatsoever, and it being connected through gears to the trolley wheels causes the larry to slowly move back and forth as the trip switch is tripped to forward and reverse. When the automatic switch is off, the disc clutch is no longer in contact and the main motor is free to run the larry and then the auto-

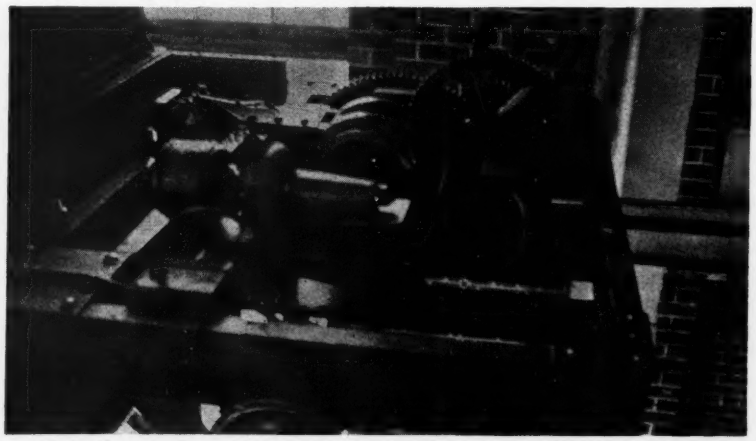


Fig. 3. View showing top of weigh larry

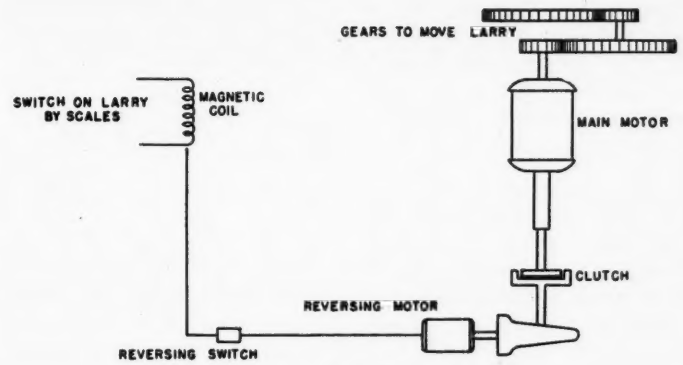


Fig. 4. Diagram of reversing mechanism

matic equipment remains inoperative.

A very interesting thing about this apparatus is the cost and materials used. By making use of scrap material picked up, any material around the plant, and building the automatic unit by the plant personnel, the cost was only approximately three dollars. For instance, the housing and gears for connecting the small reversing motor shaft to the disc clutch was part of an old cream separator. The disc clutch was taken from an old washing machine, and the reversing motor was an old cast-off motor that was rewound at the plant into a 3 phase 110 v. 1200 r.p.m. reversing motor.

This improvement of operating conditions, though costing but little, has greatly improved operation by maintaining a more level fuel bed and has cut down on dust.

An Interesting Brush Problem

Electrical energy for this plant is generated from an a.c. generator direct connected to a steam turbine. The direct current exciter for the a.c. field coils is also run off the same shaft. One day it finally occurred to the operator that one set of brushes in the exciter always wore off sooner than the other set thereby necessitating more frequent replacment than if they wore evenly and together. After thinking it out, this was the logical answer to the cause. As the current passed from the positive brush to the commutator or collector ring, the brush wore off because the current passed in that direction. On the opposite pole as the passage of current was from collector ring to negative brush, the tendency was for the ring to wear off. But the ring was hard and resisted the wear action and the negative brush did not wear. This action, of course, would wear the two sets of brushes unevenly. To overcome this difficulty, every thirty days the leads on the commutator are reversed, thus making the positive brushes negative and the negative brushes positive. This method saves the brushes to a certain extent by having them wear off more evenly, and making it unnecessary to replace them as often.

A coal strike is always a scare and source of uneasiness in a power plant. This problem has also been taken care of in good style. By using oil injected into the furnace besides the coal, a hot fire can be had and less coal will be needed.

SUMMARY OF DAILY OPERATIONS

Date July 19, 1939 Day of Week Wednesday

	SHIFT 1	SHIFT 2	SHIFT 3	TOTAL 24 Hrs.
KWH Generated (Gross)	4200	10,010	8640	22850
KWH to House Service				2960
KWH Net Output				19890
Pounds Condensate				317000
" Make Up				10995
" Evaporated				310200
Percent Make Up				3.47%
Pounds Coal Consumed	9996	16980	16430	43406
Approx. BTU/lb. as fired	Coal 10000	Oil 18000		11283
Pounds Steam per pound coal				7.30
" " " KWH Gen.				13.97
" " " " Net Output				15.94
" Coal " " Gen.	2.38	1.70	1.90	1.90
" " " " Net Output				2.18
Average Steam Pressure at Boiler				412 gage
" " Temp. at S. H. Outlet				709
" Feed Water Temp.				214
" BTU added per pound steam				1181
" " Consumed per pound steam				1548
" percent efficiency, steam generator				76%
" BTU consumed per gross KWH.				21434
" " " " net				24624
Average KWH per Hour				952
Maximum " " "				1470
Minimum " " "				390
Average Exhaust Press., Inches Hg.				1.28
" Circ. Water Temp.				71
" " " Flow GPM.				2499
Average Stack Temp.				541
" Air "				83

Remarks: Chief Operator. No. 1 machine 24 hours. Tested oil burner for 10 hours. Used 6 barrels up to 4:00 PM and 3 barrels from 7:00 PM to 10:00 PM. About 50 gal. per barrel making 450 gallons used. 6 .835 #/ gal. or 3076 # used. Heat value of oil approx. 18000 Btu/#. Total heat available from oil is then 55,368,000 B tu.

Heat added by oil 55,368,000 Btu
Heat added by coal 434,406,000 Btu
490,774,000 Btu to run plant for the 24 hours.

This test shows satisfactory results.

Fig. 5. Results of a day's run when the burners were tested

SUMMARY OF DAILY OPERATIONS

Date July 18, 1939 Day of Week Tuesday

	SHIFT 1	SHIFT 2	SHIFT 3	TOTAL 24 Hrs.
KWH Generated (Gross)	4210	10150	8690	22950
KWH to House Service				2690
KWH Net Output				20260
Pounds Condensate				309800
" Make Up				8569
" Evaporated				310400
Percent Make Up				2.76%
Pounds Coal Consumed	9970	20810	16120	46600
Approx. BTU/lb. as fired				10000
Pounds Steam per pound coal				6.37
" " " KWH Gen.				13.49
" " " " Net Output				15.88
" Coal " " Gen.	2.37	2.02	2.11	2.13
" " " " Net Output				2.40
Average Steam Pressure at Boiler				412 gage
" " Temp. at S. H. Outlet				734
" Feed Water Temp.				213
" BTU added per pound steam				1197
" " Consumed per pound steam				1570
" percent efficiency, steam generator				76%
" BTU consumed per gross KWH.				21176
" " " " net				23968
Average KWH per Hour				956
Maximum " " "				1460
Minimum " " "				380
Average Exhaust Press., Inches Hg.				1.28
" Circ. Water Temp.				71
" " " Flow GPM.				2476
Average Stack Temp.				543
" Air "				82

Remarks: Chief Operator. No.1 machine 24 hours Working on oil burner

Fig. 6. Results of another day's run showing improved operation as compared with Fig. 5

The first test with oil used a method of spraying oil on the coal at the entrance of the coal into the furnace. There were several difficulties encountered by this method. The increased heat release made it too hot in the furnace and caused the furnace walls to melt down a little. The oil would drop onto the rotor of the roto-stoker and congeal and start fire to the rotor; this, of course, was dangerous and inconvenient.

For the second trial the oil was sent through its own burners a little above the coal entrance. This way proved to be very satisfactory and showed the practicability of saving coal in this manner. Fig. 5 shows the results of the day's run when the burners were tested. Comparing these values with those of another day's run without the burners, Fig. 6, another day with approximately the same load on the plant, shows conclusively the better operation and saving of coal. It shows a higher B.t.u. heat value as fired, less coal consumed, but it shows a greater amount of steam generated per pound of coal and per kw-hr. However, the main purpose for this method of operation is to save coal at a time when the necessity arises such as during a coal strike.

Engine Temperature Control By Recirculation and Mixing

By T. NAPIER ADLAN
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New York, N. Y.

MUCH of the work of the engineer is concerned with heat transfer, which in most cases involves accurate control either to insure efficient operation, to protect against overheating or to conserve heat or water. Jacket cooling water for internal combustion engines or compressor cylinders and brine flow in refrigeration plants are typical of these requirements.

Possible arrangements are innumerable for the control and piping must be laid out to meet the needs and requirements of a specific job. Nevertheless the general principle of temperature control by recirculation or mixing are shown by the drawings for what may be considered three typical applications.

Figure 1 shows the application of a blender to a Diesel engine with a typical open system, the jacket water being pumped from the base of a cooling tower. For efficient cooling, the velocity of flow through the jackets and for efficient operation, the temperature leaving the jackets, should be kept nearly constant. The blender, with an integral thermostatic element, installed as shown, automatically bypasses sufficient warm water back to the pump suction to maintain the desired temperature "off" the engine regardless of temperature

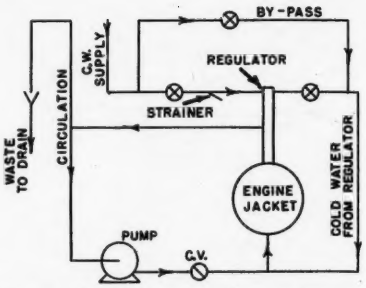

Fig. 2. Application to either engines or compressors

variations in the cold water supply from the tower. Variations of this arrangement can be used with closed systems and also where the warm water is circulated through heaters or coolers either with or without the use of waste heat boilers in the exhaust line.

A somewhat different arrangement applicable to either engine or compressor jacket cooling is shown by Fig. 2. The recirculation pump maintains the necessary or desirable flow to give good velocity while the temperature regulator installed in a discharge tee throttles the flow of cold makeup water to maintain the desired temperature at the control point. Here again many variations are possible. For instance a unit heater installed in the recirculation line would be supplied with constant temperature water, and would have no effect on the engine jacket except to change the cold makeup proportional to the heat extracted by the air flow through the heater.

Figure 3 shows the application of a blender to a milk cooler, typical of many refrigeration applications. Constant brine velocity is maintained for good heat transfer and the brine temperature from the cooler is maintained constant by automatically controlling the amount of brine recirculated.

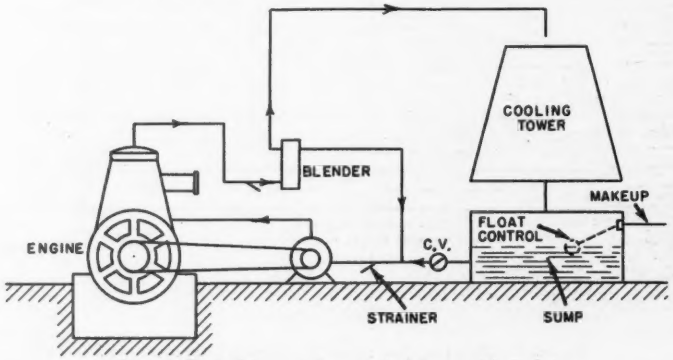

Fig. 1. Typical temperature control for engine jackets

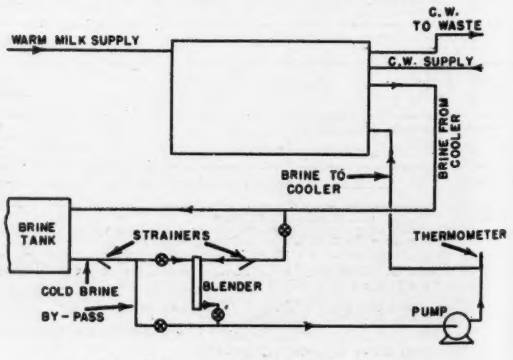

Fig. 3. Brine control on a milk cooler

Cable Care and Selection for Coal Handling

By F. L. SPANGLER

POWER DRAG SCRAPERS offer a simple method of handling coal to and from storage and many power stations and industrial plants are using them either alone or in conjunction with overhead coal handling equipment. The drag scraper is pulled back and forth over the storage area, moving coal from initial piles to any part of the area. The same equipment reclaims the stored coal by hauling the coal to hoppers or to piles at the reclaiming point.

The success of drag scraper coal storage in recent years is due to the development of a self-loading bottomless scraper bucket that gathers its load efficiently under variable conditions; stops loading when filled; retains its load while conveying; and releases its load automatically at any desired dumping point.

Watch the Cable

Many drag scraper installations employ two cables—a load cable and a haulback cable. Since cable replacement is almost always the result of individual wire breakage caused by fatigue rather than abrasion, cable that shows high resistance to fatigue, such as preformed cable, will give long service life in drag scraper installation. Preformed cable also has the advantage of being very easy to reeve and showing no disposition to "explode" or unlay when it is cut without seizings being applied. Because the individual strands and wire lie dormant, this cable has no torsional stresses, and the individual parts are free to adjust themselves and to take their full share of the load stress.

The load cable moves the bucket in the direction for filling and for conveying its load. To unload the bucket, it is simply pulled backward by the haulback cable, which also returns the bucket to the loading point. By employing separate drums for both cables, a fast haulback can be obtained. Spans as long as 500 ft. may be employed with small buckets, and longer spans with large buckets.

Where the scraper unit has the same speed on both drums, a continuous operating cable can be used instead of separate load cable and pullback cable, and the scraper bucket can be attached by clamps to this continuous cable.

The Head Post

Cables operate over sheaves in guide blocks attached to a head post at one end of the cable system and to a tail tower, bridle cable, or other suitable support at the other end. The drums on which the cables wind are usually located close to the head post.

The head post, to which the fairlead blocks are attached, may be stationary or it may take the form of a movable tower. The support for the tail blocks may be a movable tower provided with a track, or the blocks may be held by bridle cables attached to posts spaced about the boundary of the area to be served, or a retaining wall may provide the means for support.

If a stationary head post and tail post are used, the area served will be the length between the two posts, but very narrow in width. Generally the tail-block support is such that the tail block can be moved, thereby extending the area served.

To move coal from pile to storage, it is usual to locate the head post at the initial pile and the tail posts or tail tower beyond the area into which the coal is to be moved. The scraper gathers its load at the head post and drags it toward the outer boundary of the storage area. The coal can be conveyed to any part of the area served, and it can be piled to any height that does not interfere with the operation of the cables. The blocks should be so located on the head and tail posts as to allow the cables to clear the coal sufficiently to prevent a heavy cable drag, which would shorten the life of the cables and increase the power consumption.

The Tail Tower

Most installations employ traveling tail towers to support the tail blocks. These towers may move on standard-guage tracks and be equipped with propelling engines. For high storage piles, these towers must be sufficiently high to permit storage without undue wear on the cables or great difficulty in moving the cables over the pile. High towers may require wide-gage track.

Small storage systems may employ back posts of short sections of I-beams, or other structural sections set in concrete footings as shown by Fig. 1.* To these posts

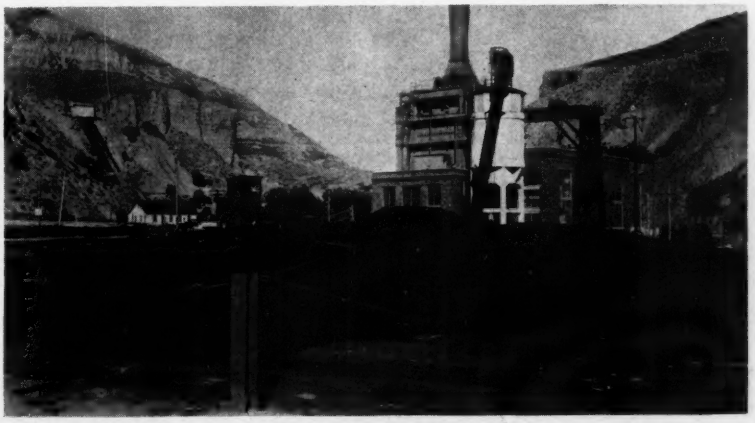

Fig. 1. Power drag scraper in small coal storage. Steel back posts are employed as supports for a movable tail bridle.

*Photographs and the chart were supplied to the author through the courtesy of Sauerman Bros., Inc.

are attached bridle cables, which may be run through roller sheaves shackled to the tops of the posts, with the ends of the bridles pinned to the bottoms of adjacent posts to act as guys. With this arrangement, a taut bridle need not result in excessive pull on the tops of the posts. The tail blocks may be moved along these bridles to shift the line of operation.

Coal is generally moved away from the head post when storing and moved toward the head post when reclaiming. To change from stocking to reclaiming, or the reverse, the scraper must be turned around so that what was formerly the haulback direction now becomes the loading direction and the former loading direction becomes the haulback direction.

Reversing the Bucket

One way to accomplish this is to run the bucket out toward the tail blocks and remove the cable and insert it into the blocks. This method is employed where separate drums are used for pull and for haulback. Where both drums have the same speed, the bucket is reversed by detaching the bucket clamps and interchanging their positions.

The handling capacity of a power drag scraper engaged in storing and reclaiming coal varies with the capacity of the bucket, the length of haul, and the speed of hauling and of returning the empty bucket. On many installations, average haulage speeds of about 300 ft. per min. are consistently maintained, irrespective of the bucket capacity, and return speeds of about 600 ft. per min.

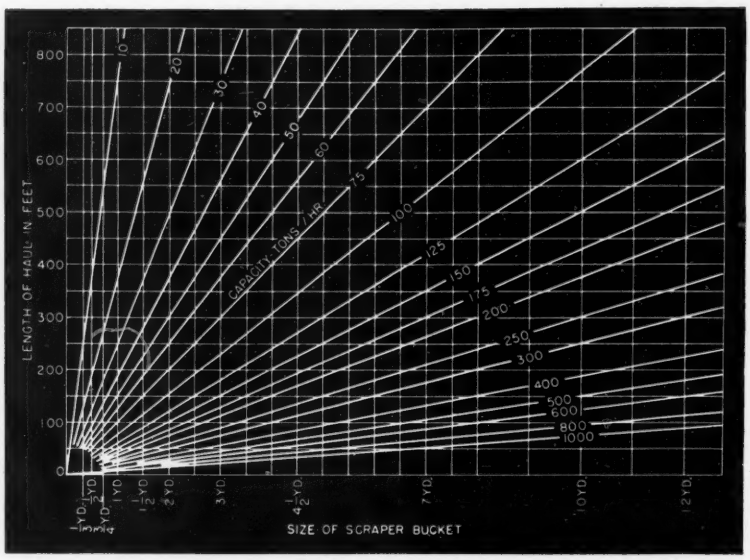

Fig. 2. Chart showing the estimated handling capacity of drag scrapers for bituminous coal weighing 40 lb. per cubic foot. Capacities given are in short tons (2000 lb.) per hr.

are common. For any given speed and length of haul, the capacity of bucket required to handle a given tonnage can be obtained by reference to Fig. 2.

Cable Selection

The selection, installation, and care of cables should be given careful consideration, since cable replacement is the chief item of maintenance on power drag scraper installations. The sheaves in the head and tail blocks should have tread diameters not less than 30 times the diameter of the cable. The two sheaves attached to the head post are generally located one below the other, with their housings pivoted on brackets so they are free to swing, thus providing a fair lead of the cables to the drums.

Nothing less than a good grade of plow steel cable should be used. Where small sheave diameters cause high bending stresses in the cable, fatigue can be delayed and cable life increased by using preformed cable. Cable lubrication is seldom a problem in coal conveying, as it is when harder and grittier materials are handled.

Where different speeds are used for haulback and for load, the haulback cable is never employed as a load cable and hence it may be of smaller diameter than the load cable. The maximum length of load cable is required when the scraper moves the coal from the head post toward the tail tower or tail post. The load cable must be at least as long as twice the distance from the head blocks to the tail blocks, plus the distance from the head blocks to the drum. When the scraper moves the coal in the direction of the head post, it requires the maximum length of haulback cable, which must equal at least twice the distance from the head blocks to the tail blocks, plus the distance from the head blocks to the drum. Hence, the required length of both haulback and load cables is equal.

Where both the haulback and the load cables are part of the same cable and the scraper is reversed by interchanging the two cable attachments, the length of

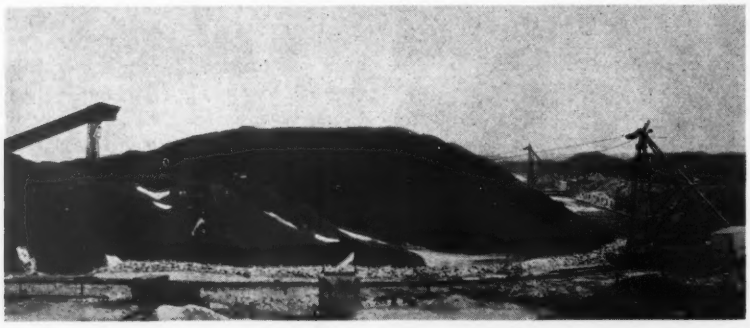

Fig. 3. Coal storage at a large coke plant with the two tail towers, one remains stationary for long periods, while the other is self-propelled for continuous mobility. The storage space is 400 by 800 ft. with a capacity of 250,000 t. Coal is brought in by rail and transferred to an elevator, which discharges the coal over the head post, forming the initial pile, from which the drag scraper hauls it to storage. Using a 6-cu. yd. scraper bucket, this installation can handle 160 t. of coal an hour, either storing or reclaiming.

Fig. 4. At this station an 8-cu. yd. power scraper system stores and reclaims 200,000 t. of coal a year. The scraper bucket operates in radial lines between a headpost and a single self-propelled tail tower, a distance of 450 ft.

the cable must be three times the distance from the head blocks to the drum.

Economies

The economies of power drag scrapers in the storing and reclaiming of coal have resulted in a growing use of this method of coal handling. Direct expenses for labor, power, and maintenance of scraper installations range from 1½ to 3½ ct. per t. of coal handled, depending on the size of the bucket, length of haul, volume of coal handled, and general operating conditions. The wage of the scraper operator is in many cases the only labor cost. The power consumption of an electric motor-driven installation averages about ¼ kw-hr. per t. of coal handled per 100 ft. of haul. An additional charge of 1 ct. per t. of coal handled will take care of all maintenance and replacement of parts.

A power drag scraper used by a certain coke plant, of which accurate cost records have been kept, has been handling 330,000 t. of coal annually at a cost per ton of 3.6 ct., or 2.6 ct. per t. exclusive of fixed charges. This figure takes account of the fact that the total consumption of 165,000 t. per year is handled twice, once in the operation of storing and again in reclaiming. The cost per ton of coal consumed is, therefore, 7.2 ct.

The scraper used on this installation consists of a 7-cu. yd. Crescent bucket, a 25-ft. head post, two 30-ft. tail towers, and a hoisting engine, with necessary blocks and cables. Each tail tower is propelled by its own electric motor, and the hoisting engine is powered with a 200-hp. electric motor, with both drums operating at the same speed. The storage yard occupies a space of 1000 ft. long by 425 ft. wide and, when coal is piled to a depth of 30 ft., has a capacity of 167,000 t.

Scraper equipment, working 6 hr. a day, handles approximately 151 t. per hr. at an average haul of 350 ft. Hauls vary from 25 to 500 ft. in length. One operator and one helper are employed.

Power drag scraper installations are extremely flexible. They can be made to serve storage yards of any size and shape. Their operating and mainteance costs are kept very low by taking advantage of the economies of bottomless buckets and of fatigue-resisting preformed cables. These advantages, together with their low initial cost, have led to their increasing use by public utilities and industrial plants for storing and reclaiming coal.

Turbine Governors Can't Talk

But then speech would probably make gossip and only detract them from more important duties. Outside of this they act and react like humans should and should be approached in the same way. Like humans governors have personal or groups characteristics, some do one thing well, some another, some are for large turbines, some for small. The author, a Clyde Beatty of the governor cage, puts them all through their paces, shows what each does best, how to handle the recalcitrants that go hunting and suggests that an IQ classification for proper selection.

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NEXT TIME you stand beside a steam turbine-generator unit which is purring along, carrying without any appreciable change in speed whatever variable electrical load is imposed upon it, you will probably look at the speed governor, as you may often have done before, and wonder what sort of a mechanism it can be to keep the machine under such perfect control.

A good way to understand the operation of a turbine governing mechanism is to consider that it is inherently no different in its reactions than a human being would be, if called upon to perform the same duty. Approach it in exactly the same manner you would employ in attempting to become acquainted with an interesting person. Of course, it might not be wise to let the engineer catch you attempting to shake hands with the governor, and you can hardly engage it in conversation, but beyond a few such handicaps, the thing is really human. It could probably be designed so that it would talk, but that would possibly distract its attention from the more important job at hand, thereby removing the superhuman intelligence which these governors often display.

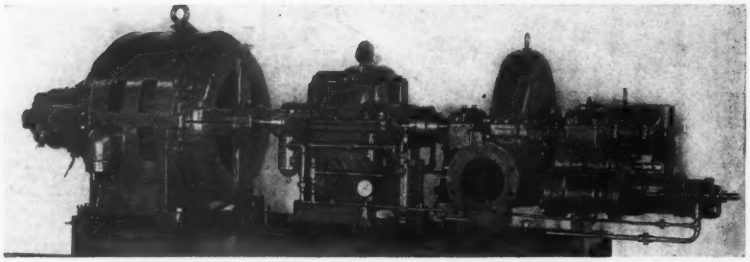


Fig. 1. Horizontal oil pilot governor

This type of governing mechanism is used principally on turbines having a single governor valve, but requiring sensitive, powerful, quick-acting governors. The typical application is for small generator drives such as the one pictured. The centrifugal type mechanical governor actuates an oil pilot valve to control the position of the oil power piston which operates the steam valve.

In an Auto—You're the Governor

Put yourself in the place of a turbine governor and imagine yourself attempting to assume the same responsibilities which the governor has. This should be no great stretch of your imagination, inasmuch as when you are driving an automobile you are certainly acting as its speed governor, and you will think from this comparison that it is an exceedingly easy task. However, in driving a car, you have a distinct advantage over the turbine governor inasmuch as you can see for some distance ahead whether you are coming to a hard pull, and must step on it, or whether you are starting downhill, and must consequently reduce the power, whereas a turbine-generator carrying an electrical load cannot anticipate a change in load until it has actually occurred. Even so, when you are driving over rough terrain, it may be a little difficult at times to hold the speedometer needle at exactly the constant speed which you expect to travel.

But getting back to the power house, if the speed governor were removed from a turbine and a simple hand valve were installed in the steam line in its place, with a frequency meter mounted near the valve in a convenient place before your eyes, there is no doubt that you could grab the handwheel of the valve and, after a little practice, hold the turbine speed approximately constant for a few hours, even with a considerable fluctuation in electrical load on the unit. As the unit begun to slow down, you would open the valve, admitting more steam and increasing the power of the turbine to the extent that it would bring the frequency back up to normal. Conversely, a decrease in electrical load would cause the unit to speed up, and you would be required to partially close the hand valve in order to bring the speed back down to normal.

The speed governor does exactly the same thing you would do yourself, the only difference being that, if you govern the unit by hand, a change in speed is detected visually by watching the frequency meter, whereas the speed governor is aware of a change in speed because of a change in the centrifugal force of rotating weights. Perhaps the governor controls several valves, all admitting steam from the steam chest into the turbine, but, except for the resultant improvement in efficiency, the principal of governing is the same as for a single inlet valve.

Extraction Type Turbine-Generator

If you are fortunate enough to have had the opportunity of observing the governing mechanism on an extraction type turbine, in operation, you may have been confused by the complicated appearance of the connecting linkages between the speed governor and the pressure regulator. The extraction turbine is, of course, a unit which not only supplies electrical power, but also supplies a certain flow of steam to process or heating lines at a pressure between throttle steam pressure and exhaust pressure.

In case of a so-called automatic extraction turbine, the pressure at which the extracted steam is removed is held constant by a pressure regulator which controls a valve inside of the turbine, closing it sufficiently to force enough steam out of the turbine to meet the extraction steam demand at the desired pressure. If, for example, the extraction pressure decreases, indicating that more steam is required to maintain the desired line pressure, the pressure regulator will close the internal valve (called an extraction valve) sufficiently to force an additional quantity of steam out the extraction opening in the side of the turbine, thus admitting less steam through the downstream end of the turbine and out the exhaust.

In a compensated type of extraction mechanism, there is an interconnection between the pressure regulator, the governor, the high-pressure steam inlet valve (commonly called governor valve) and the extraction valve. Without this compensating mechanism, it may be seen that if the governor opens its governing valve in order to supply an increased demand for electrical load, the added flow into the turbine cannot go out through the last stages and exhaust because of the extraction valve being partly closed, and as a consequence, the additional steam is forced into the extraction line,

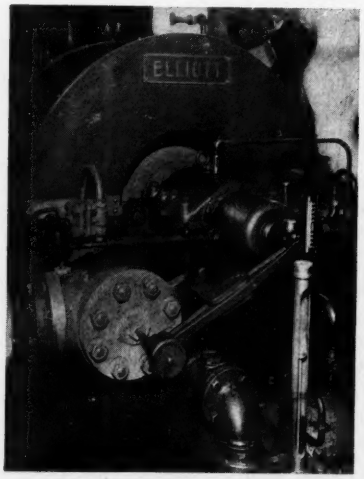


Fig. 2. This turbine uses a direct-acting mechanical governor

This type is used on small turbines having single governor valves where the chief requirement is simplicity rather than extreme sensitivity. This centrifugal mechanical governor is connected directly, by means of a lever, to the balanced type of governor steam valve.

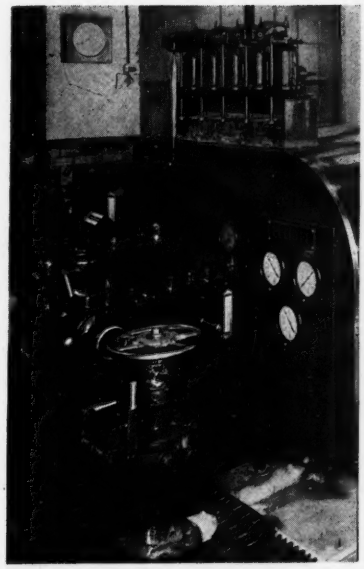


Fig. 3. The double oil relay type of governor

Used on medium and large size turbines driving generators, blowers, etc., where supersensitivity, powerful quick action, and extreme reliability are all required. It consists of a centrifugal type rotating governor which actuates an oil pilot valve in the primary oil operated power cylinder. This cylinder is connected through the horizontal governor lever to the several oil pilot valves which control the individual oil-power-operated pistons to open the governing valves in series. This type of mechanism is the champion of all turbine governors.

which raises the pressure in that line.

Without a compensating mechanism, the pressure regulator would then have to operate the extraction valve in order to correct the extraction pressure. However, with a compensated mechanism, the governor opens both the high-pressure steam valve and the extraction valve in the proper amounts to permit a given increased steam flow to pass through the entire turbine and out through the exhaust, without disturbing the extraction pressure.

This function can again best be visualized by assuming that you are operating the governor valve and watching the frequency meter, while I am watching the pressure gage on the extraction steam line and am attempting to hold that pressure constant by operating the extraction valve. Between us, we can work out a verbal compensating arrangement, whereby each time you open the governor valve in order to bring the speed back up to normal you yell to me that you are going to do so, and at the same time, I can open the extraction valve far enough to pass the added steam through the unit to the exhaust, without allowing the flow out into the extraction line to change.

The next moment, perhaps the extraction steam demand increases, which is evidenced by a slight reduction in the pressure gage reading, indicating that I must close the extraction valve a little more to force more steam out into this line. If I forget to tell you that I am closing the valve, since this operation permits less steam to go through the low-pressure stages of the turbine where it would perform useful work, the power output of the turbine momentarily becomes less than the electrical power demand, and the speed starts to fall off.

This becomes apparent on your frequency meter, and you open the steam valve enough to bring the unit back up to rated speed, thus admitting even more steam through the front end of the unit and out the extraction opening than is required. This raises the extraction pressure, forcing me to open the extraction valve a little, which increases the flow through the low-pressure stages of the unit sufficiently to speed up the machine, necessitating your closing the throttle valve a little, which, after being continued for a while, sets up a very considerable swing back and forth between speed and pressure.

Coordination Needed

However, at the moment it became apparent, because of reduced extraction steam pressure, that it would be necessary to close the extraction valve, if I had closed the extraction valve only enough to make up for part of the required difference in steam flow and had asked you to open the throttle valve enough to make up for the remaining deficiency in flow, the extraction flow would have been corrected and the speed would have remained constant.

So you see that if we attempt to operate our separate valves independently, and without any reference to what the other is doing, we develop a very annoying seesaw effect. However, if we constantly inform each other before making any change in the mechanisms we are operating, we will soon learn that if you open your valve a little, I must open mine correspondingly a little so as to pass the added steam on through the exhaust. But if I close mine partially, you must open yours sufficiently to prevent the unit speed from dropping. Thus, constantly informing each other of our intentions, we eventually arrive at the point of satisfactory compensation in our movements, and the result will be a very smooth sequence of events, enabling us to maintain the most nearly steady condition of both frequency and extraction pressure.

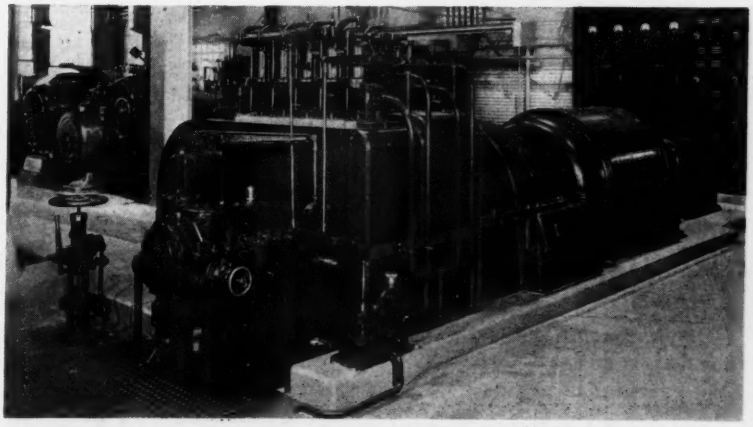


Fig. 4. The automatic-extraction type turbine governor mechanism

Combines the double oil relay type of speed governor with the automatic extraction pressure regulator, utilizing the compensating lever mechanism to operate the governor and extraction valves. On top of the turbine, behind the five individual governor valve operating cylinders, are three extraction valve operating cylinders. The speed governor is mounted in the steam end bearing case, and the pressure regulator sits on the foundation in the foreground. This mechanism is used to control a turbine-generator unit which furnishes processing or heating steam at a pressure lower than boiler pressure.

Fig. 5. The adjustable speed oil governor

Has no rotating centrifugal mechanism whatever, but, instead, the speed of the unit is controlled by pressure from an oil pump driven from the shaft. Oil pressure acts upon a bellows connected to governor valve stem. Valve is normally held open by a spring, but as the speed of the unit, and consequently, the oil pressure, increases, sufficient force is built up on the governor valve to partially close it and prevent unit speed from going above normal. Speed of turbine may be increased by opening hand valve near the bellows case to bypass more oil back to the tank. Closing this valve decreases speed of unit, and when valve is entirely closed, unit will run very slowly. While not so sensitive or quick-acting as oil relay types of governors, this governor is frequently desirable because of its extreme simplicity, ruggedness, and broad range of speed adjustment. Bellows case is shown in the foreground with a pressure gage mounted upon it. Hand control valve is shown mounted in oil piping adjacent to bellows case.

This analogy explains almost exactly the function of the compensating lever mechanism between the pressure regulator and governor on an extraction turbine. This mechanism actually goes one step farther, however, than we have considered doing by hand, inasmuch as the pressure regulator, for instance, does not merely tell the governor when it should open or close the governor valves, but, through powerful power pistons, actually moves them without the governor having to move at all, providing the load and speed are steady at the moment.

Likewise, in case the frequency must be corrected, the governor operates the extraction valve as well as the governor valves and gives the pressure regulator a rest. This eliminates the necessity of a lot of signalling back and forth between these two devices, thus providing even more nearly perfect operation than could be obtained by hand control.

Governor Troubles, Other Than Political

Regardless of how optimistic we may feel about the successful functioning of any enterprise or any piece of apparatus, it is a well-established fact that to ignore the possibility of trouble is to invite trouble.

In order to keep the governor on the job and functioning properly hour after hour and year after year, it is naturally necessary occasionally to give a little consideration to its general welfare. In this respect, a turbine governor is most human, since good living conditions are always required for alertness and dependability. You can do a great deal toward preventing crankiness and sluggishness by keeping surroundings clean and keeping constitution "regular." For this purpose, an occasional dose of the proper grade of mineral oil is just as good for one type of governor as for another, unless this function is automatically taken care of by internal devices.

If, in spite of normal care, some unfamiliar trouble develops, it is wise to call in a specialist who will be able to correct not only the basic faults, but also to administer a general tune-up at the same time.

One of the first symptoms showing that a governor is not attending to its business properly is evidenced by the fact that it frequently goes "hunting," which annoys the operators just as much as it annoys the Republicans when the President goes fishing. The term "hunting" as applied to turbine governing usually implies a continuous swing in speed and governing mechanism, of a rhythmic beat, and of sufficient magnitude to be disturbing to the power system. If you were to ask me what the governor is hunting for, I would guess for the average speed and proper valve position which will satisfy the existing electrical load demand. In other words, it is hunting for a place to rest.

Hunting

While there may be several reasons why a turbine governor hunts, the first thing the specialist will look for is either lost motion, due to excessive wear, or friction and stickiness caused by corrosion, improper lubrication, or the accumulation of scale or grit.

If you wonder why lost motion will cause a governor to be unstable or to hunt, you should try to start up a turbine, and hold it at some constant speed while it is warming up, by means of a throttle valve which has sloppy threads, or in which the valve is loose on the stem. After starting the machine rolling over, you decide that the speed should be increased slightly, so you give the throttle handwheel a little nudge and because of the lost motion, nothing happens.

Then you give it another little nudge, and since nothing happens this time, you give it a good heave and the speed jumps up 500 r. p. m. or so. In attempting to slow it back down, you turn the handwheel a little — a couple of times — and nothing happens, until finally the lost motion is all taken up, the valve starts to move before you ralize it, and you have gone down to too low a speed. Then you are off on a hunt as the speed goes up and down. This is exactly what happens to a governor operating under similar circumstances.

Excessive friction has much the same effect, except that the first couple of times you attempt to turn the handwheel, it refuses to budge, and finally when you put on sufficient pressure to break the static friction, it jumps too far

and has to be brought back to the proper position — which is often very difficult. If it wears you out to attempt to fight such a condition by hand, you may be equally sure that it wears a governor out to have to contend with such conditions, so that they should be corrected as soon as it is observed that sluggishness, jumpiness, or hunting has developed.

GOVERNOR I. Q.

Since it is an established fact that there is a great deal of variation from one person to another in their abilities to learn, to observe, and to perform, various states have established a uniform system of examinations, by means of which they expect to roughly classify individuals and to establish the intelligence quotient (I. Q.) of the school children.

Assuming then that the performance of a certain duty requires a person of a given intelligence quotient, it should be possible theoretically to select someone by this method of classification whose ability would be just sufficient to satisfactorily execute the duties involved. By the same token, it is sometimes possible to analyze the requirements of a turbine governor, before it is even selected, and write a set of specifications covering the ideal governor for the job. It should then be possible to classify various governors by this specification, and establish the I. Q., or relative fitness, of each governor for the work involved.

Since a considerable variety of turbine governors are manufactured, it is generally possible to make such a selection from available products, and the performance of a governor selected in this manner will usually be eminently successful. Some machines require very sensitive and accurate governors, while others require powerful, durable governing equipment. The selection of the wrong type of governor might be just as unwise economically as choosing a big laborer to perform an executive duty, or to pay a vice-president's salary to a man for heaving coal.

On the other hand, knowing the governing requirements of your power system, and having selected the proper type of governor for any given job, if you will treat it with human consideration, you can expect it to respond as cheerfully and reliably as any employee in your power plant.

Electric Power Load and Growth

Generating capacity during 1939 increased 1,275,819 kw. with 1,877,844 kw. scheduled for completion during, and 2,411,475 kw. subsequent to 1940. Production reached a new peak of 130,336 million kw-hr. an increase of 12 per cent over 1938. Future scheduled expenditures approach the billion dollar mark.

CLOSELY FOLLOWING the announcement of a major turbine manfacturer that orders for the first half of this year total nearly 2 million horsepower (about half stationery and half marine) comes the release of figures by the Federal Power Commission, on the electric power production for 1939.

A new peak of 130,336,000,000 kw-hr. represents an increase in production of about 12 per cent over 1938. About 66.2 per cent of the total was produced in fuel burning plants and the balance by hydro, which, due to the lack of rainfall, dropped 1.8 per cent below the 1938 figures. Fuels used during the 2 yr. is shown by Table I and the 1939 power production by states in Table II.

Average consumption of equivalent fuel was reduced to 1.39 lb.

Table I. Comparison of fuel consumption for 1938 and 1939 for plants generating electric energy. [1]Weighed average heat content of: coal expressed in B.t.u. per lb.; oil in B.t.u. per bbl.; and natural gas in B.t.u. per cu. ft. Includes crude oil, fuel oil and distillate. [2]Includes gas mixtures containing natural gas and manufactured or by-product gas

	CONSUMPTION OF FUEL		AVERAGE BTU PER UNIT[1]		THOUSANDS OF KILOWATT-HOURS PRODUCED		HEAT RATE BTU PER KILOWATT-HOUR		THERMAL EFFICIENCY PERCENT	
TYPE OF FUEL	1938	1939	1938	1939	1938	1939	1938	1939	1938	1939
ANTHRACITE COAL (Short Tons)	1,966,840	2,243,984	11,107	11,107	2,077,217	2,369,338	21,033	21,039	16.2	16.2
BITUMINOUS COAL (Short Tons)	36,790,940	42,441,038	12,673	12,673	53,697,973	63,074,896	17,365	17,054	19.6	20.0
LIGNITE (Short Tons)	1,454,202	1,538,174	7,453	7,453	1,115,915	1,192,775	19,424	19,222	17.6	17.8
ALL COAL (Short Tons)	40,211,982	46,223,196	12,408	12,423	56,891,105	66,637,009	17,541	17,235	19.5	19.8
OIL[2] (42 Gal. Bbl.)	13,077,113	17,423,456	6,294,155	6,294,155	4,862,029	7,375,305	16,929	14,869	20.2	22.9
GAS[3] (MCF)	170,688,142	191,130,940	1,045	1,045	9,771,512	11,787,871	18,254	16,944	18.7	20.1

Table II. Production of electric energy during 1939 by states, in thousands of kilowatt-hours

STATE	PRODUCTION OF ELECTRIC ENERGY
Alabama	3,943,236
Arizona	1,327,485
Arkansas	230,799
California	9,402,588
Colorado	760,445
Connecticut	1,986,512
Delaware	16,045
Dist. of Columbia	1,116,317
Florida	1,149,900
Georgia	1,612,092
Idaho	1,126,516
Illinois	8,200,459
Indiana	4,465,165
Iowa	2,108,681
Kansas	1,270,218
Kentucky	913,409
Louisiana	1,885,223
Maine	873,636
Maryland	2,144,406
Massachusetts	3,428,084
Michigan	6,010,047
Minnesota	1,675,639
Mississippi	67,127
Missouri	1,604,580
Montana	1,575,016
Nebraska	804,171
Nevada	1,855,042
New Hampshire	739,457
New Jersey	4,598,663
New Mexico	281,598
New York	17,324,501
North Carolina	2,488,617
North Dakota	226,165
Ohio	8,339,408
Oklahoma	1,111,804
Oregon	1,484,468
Pennsylvania	11,049,788
Rhode Island	732,013
South Carolina	1,568,009
South Dakota	162,241
Tennessee	2,044,177
Texas	3,751,868
Utah	426,474
Vermont	201,288
Virginia	1,975,120
Washington	3,642,610
West Virginia	3,219,603
Wisconsin	2,979,924
Wyoming	141,156
United States	130,836,050

of coal per kw-hr., a considerable reduction from the 1938 figure of 1.41 and less than half that for 1920, 3.36 lb. The most efficient plant reporting showed a figure of only 0.8 lb. The heat rate and thermal efficiency of Table I is included for the first time.

Of the nearly 14 bil. kw-hr. increase over 1938 production of 116,681,000,000 kw-hr., privately owned plants accounted for approximately 10,813,000,000 and publicly owned plants approximately 2,841,000,000 kw-hr. Table IV shows the production of electric energy by class of ownership and type of prime mover. Grand totals of the table for both classes of ownership are: hydro plants, 444,021,631,000 kw-hr., steam, 85,006,941,000 kw-hr., internal combustion engines, 1,307,478,000 kw-hr. During the year a net balance of 1,900,351,000 kw-hr. was imported from foreign countries (Canada and Mexico) about 97 per cent of the total over transmission lines from Ontario into New York State.

Installed capacity increased some 1,275,819 kw. to a peak of 40,318,000 kw. and more significant is the fact that budgeted expenditures for 1940 total $593,879,533 and involves about 1,877,844 kw. of capacity. About 82½ per cent of this expenditure is to be in privately owned plants. Scheduled additions subsequent to 1940 are already up to 2,411,475 kw., about 69 per cent in the private field.

Detailed figures on this new construction in private plants are as follows: hydro, $3,337,110 and $57,000 kw., steam, $150,781,568

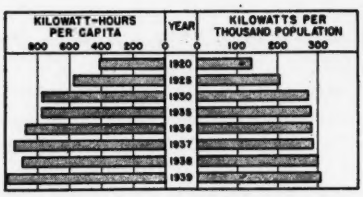


Fig. 1. Production of electric energy per capita and capacity per thousand population from 1920 to 1939

and 1,264,085 kw.; and internal combustion engines $1,098,967 and 11,550 kw. Corresponding figures for the publicly owned group are: hydro, $46,731,000 and 234,175 kw.; steam, $21,273,242 and 270,372 kw.; and engines $3,838,678 and 40,662 kw.

Since 1920 the rate of growth of internal combustion engines has been four times that of hydro plants and almost 5 times that of steam plants but in spite of this rapid growth, engines by the end of 1939 amounted to only 2.1 per cent of the total installed capacity, while hydro accounted for 28.3 and steam for 69.6 per cent. Increases for 1939, in kilowatts of capacity are: hydro, 349,102; steam, 844,104 and internal combustion engines, 82,613.

On a per capita basis installed capacity has increased from 136 kw. per thousand of population in 1920 to 307 kw. in 1939, while the per capita consumption has increased more rapidly from 410 kw-hr. as 1920 to 994 in 1939. This indicates that not only are people

Table III. Installed capacity of all types of generating plants by class of ownership since 1920. The capacity of plants producing energy exclusively for their own use is not included

YEAR	TOTAL – ALL CLASSES OF OWNERSHIP	PRIVATELY OWNED				PUBLICLY OWNED					
		ELECTRIC UTILITIES	MINING AND MANUFACTURING	RAILWAYS AND RAILROADS	SUBTOTAL	MUNICIPAL ELECTRIC UTILITIES	FEDERAL		COOPERATIVES POWER DISTRICTS STATE PROJECTS	NON-CENTRAL STATIONS	SUBTOTAL
							BUREAU OF RECLAMATION	OTHER			
1920	14,372	12,023	113	1,545	*13,681*	601	10	0	21	59	*691*
1921	15,282	12,797	95	1,668	*14,560*	634	11	0	21	56	*722*
1922	15,950	13,419	88	1,670	*15,177*	685	11	0	21	56	*773*
1923	17,433	14,787	100	1,691	*16,578*	752	14	0	33	56	*855*
1924	19,493	16,740	135	1,677	*18,552*	824	14	0	44	59	*941*
1925	23,512	20,045	268	1,772	*22,085*	1,125	14	184	49	55	*1,427*
1926	25,392	21,819	274	1,732	*23,825*	1,204	21	184	99	59	*1,567*
1927	27,021	23,418	369	1,573	*25,360*	1,210	25	184	131	111	*1,661*
1928	29,714	25,991	445	1,464	*27,900*	1,346	29	184	139	116	*1,814*
1929	31,623	27,953	420	1,363	*29,736*	1,424	30	184	138	111	*1,887*
1930	34,055	30,285	438	1,233	*31,956*	1,601	32	194	154	118	*2,099*
1931	35,370	31,498	431	1,241	*33,170*	1,696	37	194	154	119	*2,200*
1932	35,991	32,033	388	1,216	*33,637*	1,828	38	194	155	139	*2,354*
1933	36,243	32,163	458	1,198	*33,819*	1,879	38	194	172	141	*2,424*
1934	35,791	31,547	449	1,224	*33,220*	1,963	38	250	182	138	*2,571*
1935	36,074	31,820	449	1,190	*33,458*	2,001	38	262	175	139	*2,615*
1936	36,565	31,787	447	1,036	*33,270*	2,164	407	396	184	144	*3,295*
1937	37,134	31,958	494	1,020	*33,472*	2,477	407	425	207	146	*3,662*
1938	39,042	33,246	559	991	*34,796*	2,631	572	584	310	149	*4,246*
1939	40,318	33,908	559	896	*35,363*	2,807	768	883	333	164	*4,955*

Table IV. Production of electrical energy in thousands of kilowatt hours for private and public plants and different types for prime movers

TYPE OF PRIME MOVER	PRIVATELY OWNED			
	ELECTRIC UTILITIES	MINING AND MANUFACTURING	RAILWAYS AND RAILROADS	SUBTOTAL
Hydro	35,223,219	411,058	46,946	35,681,223
Steam	79,472,819	434,130	1,789,070	81,696,019
Int. Comb.	381,881	6,063	6,979	394,923
Total	115,077,919	851,251	1,842,995	117,772,165

	PUBLICLY OWNED					
	MUNICIPAL ELECTRIC UTILITIES	FEDERAL		COOPERATIVES POWER DISTRICTS STATE PROJECTS	NON-CENTRAL STATIONS	SUBTOTAL
		BUREAU OF RECLAMATION	OTHER			
Hydro	2,139,019	2,691,919	2,488,543	849,071	171,856	8,340,408
Steam	2,756,512		277,940	1,752	274,718	3,310,922
Int. Comb.	792,704		17,296	93,455	9,100	912,555
Total	5,688,235	2,691,919	2,783,779	944,278	455,674	12,563,885

using more power but that plants are being utilized to better advantage than during the immediate post war period. Figure 1 shows graphically the capacity and utilization figures. The population in 1920 was 105,710,620 and in 1939, 131,179,000.

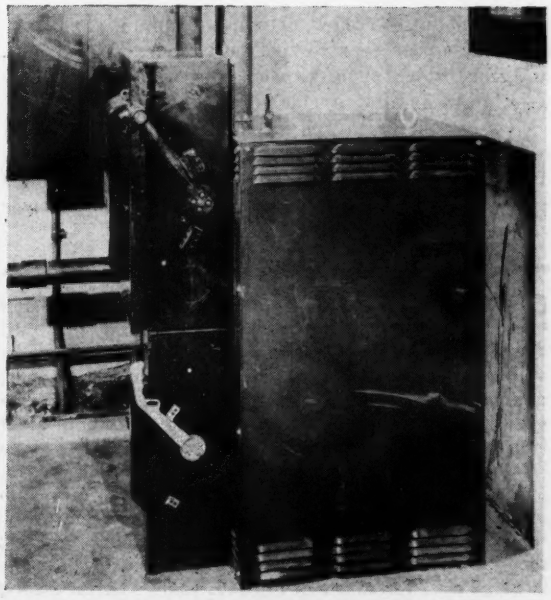
A measure of the improved operating performance is shown by a comparison of plant factor, indicating the percentage of time a generating plant is in operation and producing power. For 1939, this figure was 37.5 per cent, a material increase over 31.3 per cent for 1935. The effect of the depression on this factor is however apparent from plant factors for earlier years. In 1920 it was 34.3 per cent, increased to 34.9 in 1925 but dropped to 32.9 in 1930.

Table III shows the installed capacity of all types of plants for a 20 yr. period during which the total capacity was more than tripled by an increase of approximately 26 mil. kw. About 22 mil. kw. of this was added by the private utilities but the rapid rate of increase of publicly owned plants, particularly the federal and cooperatives during recent years is apparent, more than 1:5 mil. kw. increase since 1934.

Transformers Increase Capacity of Lighting Circuit

AN INSTALLATION of 39 air cooled transformers solved the problem of obtaining increased wiring capacity for better lighting in the American Furniture Mart in Chicago. This building was confronted with a problem that prevails in many office and manufacturing buildings throughout the country—that of bringing the capacity of the lighting circuits into line with the requirements imposed by modern lighting practice. Largest of its kind in the country, the Mart is divided into sections which are rented to various furniture manufacturers. Originally each section was equipped with ten ceiling lighting units using 200-watt lamps. Wanting better light, the tenants gradually increased the size of their lamps until some were using the 500-watt size.

The transformers, installed singly and in pairs along the corridors of the various floors of the 15-story mart, are General Electric units of 60-cycle, 75-kv-a., 460-230/115 v. rating. Power carrying capacity of the risers is doubled by increasing distribution voltage from 230 to 460 v. and then transforming to 230 again at load centers. Installing the air-cooled transformers eliminated considerable switchboard work; replacement of the fuse clips with 460-v. clips was the only change necessary in the existing equipment.



One of the Transformer Installations. The installation of these transformers made it possible to raise the distribution voltage which in turn obviated the necessity for the use of larger "copper".

Recent Developments in Com-

DURING the past ten years power stations and industry have increasingly used air circuit breakers for a growing variety of services. While the first devices used for the interruption of electrical circuits were of the air break type the interrupting capacity of the early air circuit breakers was extremely limited and for high voltages and high capacities, the circuit breaker art, almost from the time of its inception has depended upon the use of oil as an interrupting medium.

The choice of oil was based upon its excellent insulating properties and its remarkable arc quenching ability. Oil and its vapor can be ignited, however, and thus can constitute a serious fire hazard under abnormal operating conditions. This factor has long been recognized but practical operations of electrical systems has demonstrated that oil fires directly chargeable to circuit breaker failures have been negligible. Recently, however, growing demand on the part of operators and the development of the principle of oil-less circuit interruptions in Europe have combined to strengthen the interest in oil-less circuit breakers in this country.

The first major contribution in the oil-less breaker field in this country was the development of the De-ion air breaker in 1928 by The Westinghouse Electric and Mfg. Co. This breaker was based upon the fundamental research of Dr. Slepian of Westinghouse on the mechanism of deionization. Prior to this time air circuit breakers had been used for many years with unquestionable success in lower voltage circuits in which limited interrupting capacity was sufficient. The De-ion breaker, however, interrupted an arc in air using entirely new principles and so effectively that it has been constructed for voltages up to 23 kv. and for interrupting capacities as high as 750,000 kv-a. at 15 kv. or 1,500,000 kv-a. at 23 kv.

Greater interrupting capacities are continuously being required and for interrupting capacities above 1,500,000 kv-a. other forms of oil-less breakers offer attractions. Principal among these is the air blast or compressed air circuit breaker.

FEW BRANCHES of the electrical art have been marked by such outstanding development during the past decade as the circuit breaker field. In years past, in the editorial columns of this publication we, more than once, directed attention to the fact that circuit breakers were expensive, unwieldy things which could withstand great improvement. Since about 1930, however, this has no longer been true. With the advent of the De-ion breaker around 1930 and the subsequent developments in both air and oil circuit breakers, the entire art has been revolutionized and today, comparatively small oiler breakers show performance characteristics, unattainable by the large oil circuit breakers of previous years. Latest among the developments in the circuit breaker field are the compressed air breakers described in this article.

These compressed air breakers had been used in Europe for some time and while the service performance of these European breakers was satisfactory their inherent limitations prevented their adoption in this country where large values of fault current and high rates of rise of recovery voltage are the rule rather than the exception.

The departure from oil in Europe began with the introduction of both compressed air and water breakers in 1929 and 1930. The new trend was accelerated there because of the high price of oil and metals and because the limited capacities for which compressed air or water circuit breakers could be built were sufficient to meet European requirements.

Considerable development has been done in Europe with both types of breakers. The field of application for oilless breakers in Europe is becoming extensive and for some manufacturers is including the higher voltage and outdoor types but in America, by contrast, the immediate demand is limited to indoor oilless breakers.

This demand for a high capacity circuit breaker of the air break type led American manufacturers to make tests and undertake the development of breakers which would meet the requirements. In Europe the compressed air circuit breaker, as has already been pointed out, was in successful use within the limitations of the European requirements so it was natural for American manufacturers to attempt to improve this type of breaker.

Fundamentally, the theoretical basis of operation of the air blast breaker is similar to the oil blast breaker. It consists in the displacement of the arc stream and the replacement of the arc products with insulation at a rate which will prevent breakdown of the dielectric by the recovery voltage. In the air blast breaker a stream of air under pressure displaces the arc stream. The various manufacturers of such breakers are not entirely in agreement as to the theory of operation but these differences of opinion need not be considered here.

In Europe air blast breakers of both axial and cross blast design were developed but variations of the nozzle type, that is the axial type, have become most popular. They consist of an orifice through which an arc is drawn or blown and then subjected to a very intense longitudinal blast of air. This air supply may be obtained from a compressed air storage tank or the blast of gas may be obtained by the decomposition of suitable materials by the heat of the arc. In Europe circuit breakers have been produced commercially where a synthetic resin is used for producing the gas blast. In this country, Westinghouse has produced self-generated gas blast breakers of two types, one utilizing boric acid in close proximity to the arc drawing contacts with suitable boric acid lined arc chutes into which the arc is driven by the expelled arc gases. The other is a two-arc interrupter

pressed Air Circuit Breakers

shown in Fig. 1. One arc is established through a conventional orifice and subjected to a longitudinal blast of gas in quite the same manner as used in continental compressed air breakers. The other arc is drawn in a space closely surrounded by gas producing walls. This arc is not relied upon to supply interrupting ability except for low values of current, but to supply the gas blast for the first mentioned arc. This interrupter has handled currents up to 48,000 amp. at 7.6 kv. The arcing time for the high values of current usually did not exceed two half cycles, yet pressures as high as 1000 lb. per sq. in. were recorded.

While this type of breaker undoubtedly has possibilities all of the more recent developments in air circuit breakers in this country have been along lines which utilize an external air supply. Both Westinghouse and General Electric have developed air breakers of this kind employing the cross blast principle while Allis-Chalmers uses a radial blast type of design. These three designs will now be considered in some detail.

The Westinghouse Compressed Air Circuit Breaker

As expressed by Messrs. Ludwig, Rawlins and Baker, all of the Westinghouse Electric and Mfg. Co., in a paper presented before the American Institute of Electrical Engineers,[1] the Westinghouse breaker is an extension of a principle used for many

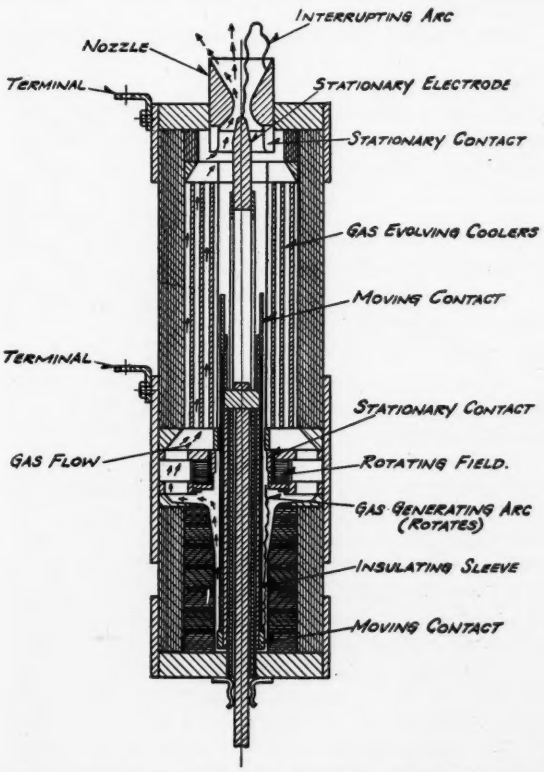


Fig. 1. Self-generated gas blast circuit breaker developed by Westinghouse. Shown in open position.

The Westinghouse Compressed Air Circuit Breaker

years in a different way. For many years magnetic fields have been used to extinguish arcs by blowing them into some type of arc chute which lengthens and constricts the arc. Recently a new means of effecting interruption with a magnetic field was developed. An interrupter of this type consists of parallel insulating plates spaced apart and slotted at the lower end. The arc is driven into this slot by means of a magnetic field. When the arc reaches the upper portion of the slot the magnetic field exerts a force on the electrons in the gas stream and gives them a component of velocity transverse to the arc. These electrons in turn bombard neutral gas particles, with the final result that a blast of gas is caused to flow upward through the arc path. When current zero is reached this blast of gas effectively introduces a strong deionizing action at the end of the slot which effectively extinguishes the arc. While breakers using this principle of arc interruption have been developed the principle is not sufficiently effective for the interruption of currents as high as 60,000 amp. at 15,000 v.

A more effective air stream can obviously be produced by utilizing compressed air in the type of arc chamber just described. In this case the magnetic field is no longer necessary. An external air supply must be provided, of course, but in view

[1] A new 15 kv. Pneumatic Circuit Breaker. A. I. E. E. Technical Paper 40-64 presented before the A.I.E.E. Winter Convention, Jan. 1940.

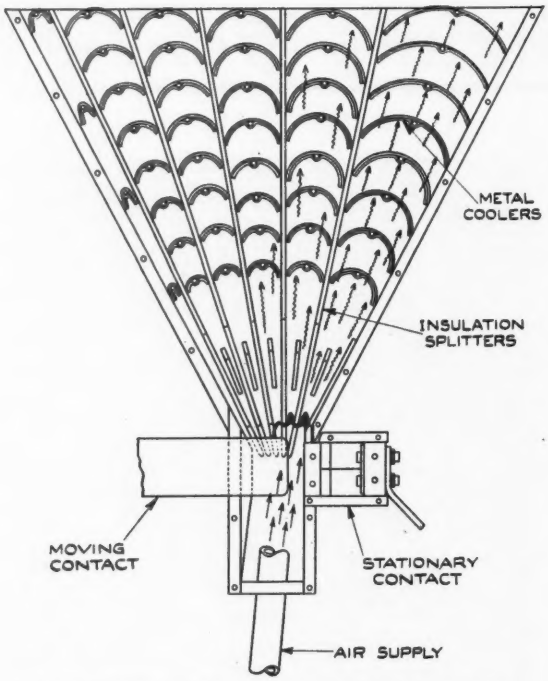


Fig. 2. Diagram of the arc chamber of the Westinghouse Compressed Air Breaker

of the extremely high interrupting ratings which can be achieved in very small space, the use of compressed air in conjunction with an arc chamber of the type described appeared to Westinghouse engineers to be the most feasible method of proceeding toward the design of a breaker having sufficient interrupting capacity to meet all indoor requirements. A comparison of the interrupting ability of a compressed air device built in this manner with known types of compressed air breakers utilizing nozzles for interruption convinced Westinghouse engineers that the air stream perpendicular to the arc path in conjunction with insulating plates was much superior.

The construction of this interrupter is shown in Fig. 2. The contacts and surrounding walls are arranged so that the arc is blown by the air stream from its point of inception against suitable insulating splitters. There the arc remains practically stationary and substantially perpendicular to the gas blast throughout the arcing period. During this time the gas is allowed to escape around the sides of the arc freely enough to prevent building up of pressure sufficient to interfere with the continuity of the arc stream and at the same time sweeps the excess ionization from around the arc out into the space beyond the splitters. Thus, as the current zero approaches, the residual ionization associated with previous high current has been removed without high arc voltage, and the time between current zero and restored voltage becomes adequate for interruption even though the voltage recovery rate is high.

The supply of compressed air for breakers of this type is of course a very important consideration. If a large number of breakers are installed, two independent systems are used for the air supply. Each consists of a compressor unit, two storage tanks, cooling coils for the condensation of water vapor contained in the air, and the necessary auxiliaries. It is expedient to store the air of 250 lb. pressure and to use a reducing valve to drop this pressure to 150 lb. in the air line and breaker tanks in order to store the greatest amount of of air with the least space required. Fig. 3 is a diagram of a system involving two complete air supply systems connected to six circuit breakers. Each circuit breaker is equipped with a storage tank containing sufficient air for two circuit interruptions with the supply cut off. About 20 lb. of air is used for each closing operation. The breaker will open 1,500,000 kv-a. with a tank pressure of 105 lb.

The mechanism of this breaker consists of an air cylinder in which a piston moves vertically. This piston is connected by necessary cranks and levers through insulating pull rods to each of the three movable contacts. It is unnecessary to interpose any trip free mechanism since entirely equivalent results can be obtained with proper control of the air operating mechanism itself.

It is particularly important that the breaker cannot be opened unless the interrupting air blast is previously turned on since in compressed air circuit breakers the contacts are not normally immersed in the interrupting medium. Direct mechanical connection between the contacts, the mechanism and the blast valve which controls the interrupting air stream is the most certain method of insuring coordination between contact motion and blast valve operation.

The General Electric High Capacity Air Blast Circuit Breaker

The principles and the construction of the General Electric Cross Blast Air Circuiit Breaker is shown in Fig. 4. This breaker, like the Westinghouse breaker, also was completely described in papers presented before the A. I. E. E.[2] It consists essentially of four major components: 1 an arc chute with movable contact; 2, an air blast valve; 3, an operating mechannism; and 4, a control valve.

Fundamentally, as explained by the General Electric engineers the basis of operation of the breakage is the displacement of the arc stream and

[2]Design and Construction of High Capacity Air Blast Circuit Breakers. A.I.E.E. Technical Paper 40-63 by Messrs. H. E. Strang and A. C. Boisseau. The Cross Air Blast Circuit Breaker. A.I.E.E. Technical Paper 40-19 by Messrs. D. C. Prince, J. A. Henley and W. K. Rankin.

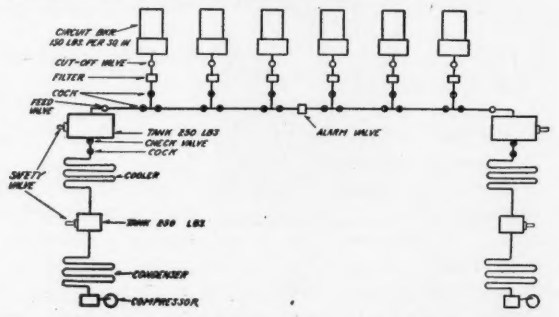


Fig. 3. Diagram of a compressed air system for a group of six circuit breakers

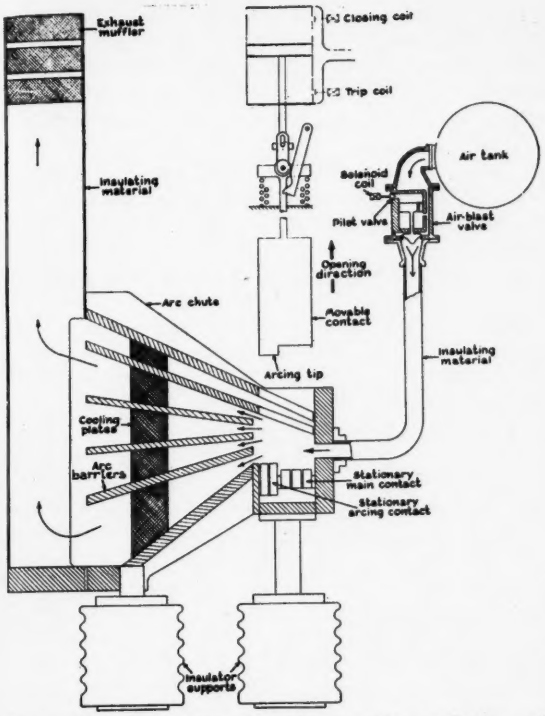


Fig. 4. Schematic diagram of breaker operating mechanism and control

the replacement of the arc products with insulation at a rate which will prevent breakdown of the dielectric by the recovery voltage. A stream of air under pressure displaces the arc stream and at the zero point of the current wave, purges the interrupting chamber of the hot gases. The flow of air across the separating contacts then provides the necessary dielectric strength at the required rate to prevent breakdown by the recovery voltage.

The arc chute is a box structure of simple, compact design combined with great mechanical strength. Within this structure are the interrupting chamber, stationary contacts, cooling plates, arc barriers and exhaust vent.

The section at the right of the arc chute (Fig. 4) is the chamber in which the actual interruptioon of the arc occurs. The sides consist of blocks of insulation material with a contour designed to force the blast of air directly across the arc stream. A false top barrier containing an opening with relatively small clearance, through which the movable contact passes, forms the top while the back plate of the arc chute is also the back of the interrupting chamber and contains the entrance orifice for the air blast. The fixed contact assembly is at the bottom of the chute, centrally located between the two insulating blocks.

Arc barriers placed at the exit of the interrupting chamber divide this portion of the interior of the chute into four passages, each equipped with cooling plates. A fifth passage which also contains a cooler exists between the false and actual top barriers. All of these passages exhaust into a vertical event where additional cooling members are installed.

The orifice in the back plate of the arc chute is located so that the normal flow of air is directly across the fixed contacts and in the plane of the longitudinal axis of the tips of the fingers. This flow of air forces the arc between the streamlined side members of the interrupting chamber and into the exit passages at the front of the chamber. In order to obtain short arc duration and minimum deterioration of parts, approximately 15 cu. ft. of free air at 150 lb. initial pressure are required for a closing-opening operation on a triple pole, 15 kv. 500,000 kv-a. breaker, while a 1,500,000 kv-a. breaker requires approximately 25 cu. ft. for such an operation.

The coolers in the arc chute to function properly it is essential that a reliable valve be used to control the admission of the air blast. A high speed differential type, solenoid-pilot operated valve has been designed for this purpose. It is of primary importance that the pressure drop through this valve be kept as low as possible and every effort has been made to provide a straight line flow with a minimum of obstructions. Under intermittent flow conditions at a rate of 78 cu. ft. of free air per min., the pressure drop through this valve is only about 10 pounds with an initial tank pressure of 150 lb. gage.

The operating mechanism consists, essentially, of two units, a double ended cylinder and a straight line linkage mechanism, shown in Fig. 4. The piston is directly connected to the straight line linkage mechanism through a pair of slotted links which permit a short stroke of the piston before the motion is transmitted to the contacts. The blast of air on closing is controlled by an interlock switch which both energizes and deenergizes the solenoid on the blast valve pilot at a predetermined point in the stroke.

Each breaker has its own individual air storage tank, containing a sufficient supply for two closing-opening operations at full interrupting capacity. A central compressor and storage system may be located at any convenient remote point, and connected by a manifold and non-return valves to the breaker tank units.

The Allis-Chalmers Air Blast Breaker

The Allis-Chalmers Air Blast Breaker differs from

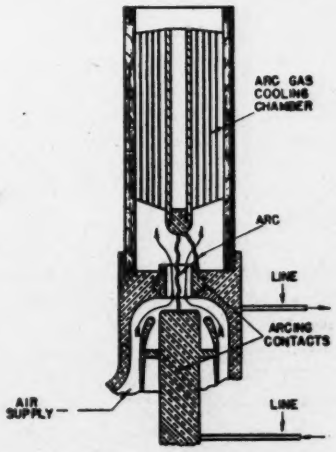


Fig. 5. Typical axial air blast interrupting chamber

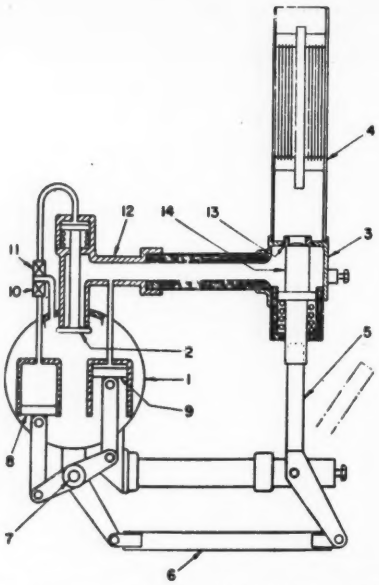


Fig. 6. General arrangement of the Allis-Chalmers, type AB circuit breaker

the General Electric and the Westinghouse breakers in that it is of the axial blast type. As already pointed out in this article, in Europe the axial blast type of breaker has gained preference over the cross blast type. In developing their air blast breaker the Allis-Chalmers engineers took into account the great amount of operating experience and evolutionary test data available on the axial blast breaker and used this as the basis for their starting point in design.

In the typical European type of axial air blast breaker interrupting chamber, the compressed air approaches an orifice through a converging port, and exhausts through a diverging throat. In many European designs, too, the interrupting contact is a part of the isolating contact. This makes for inefficiency of the interrupting air blast.

As a result of extensive research and as reported in a paper before the A. I. E. E.[3] Allis-Chalmers engineers found that the arrangement of interrupting chamber shown in Fig. 5 has a greater interrupting efficiency, particularly at high currents, than the Europan converging-diverging chamber. It will be noted from Fig. 5 that the American development incorporates a structure having parallel walls. Redesign of the cooling chamber to obtain increased air velocity, and the introduction of concentric metallic cylinders within the arcing chamber produced further improvement. Main current carrying contacts, distinct from the arcing contacts, were also added.

Incorporating these improvements over the European type, the Allis-Chalmers axial air blast breaker produces a practically constant circuit interrupting characteristic with the result that arcing times of one-half cycle or less are consistently produced throughout the interrupting range of any particular breaker. As in the case of the General Electric and Westinghouse breakers, the Allis-Chalmers also uses the prestored energy of compressed air, both for circuit breaker operation and circuit interruption.

The general arrangement of the Allis-Chalmers breaker is shown in Fig. 6. A compressed air tank (1), fitted with a main air blast valve (2), forms the foundation on which the active parts of the breaker are mounted. The arcing chambers (3) and disconnect movable members (5), are supported by hollow insulator columns attached to the tank assembly. The arcing chambers exhaust into cylindrical mufflers. Operation of the disconnects is achieved through insulated link (6) and shaft (7) connected to the air pistons (8) and (9). Valves (10) and (11) control the air supply.

When opening, electrical or manual actuation of control valve (11) results in opening the air blast (2) admitting air at 135 lb. or 215 lb. per sq. in. into the interrupting chambers. Movable arcing contact (14) normally held closed by the action of heavy springs, is attached to a piston. As air pressure builds up within the interrupting chamber, the piston is depressed, withdrawing contacts (14) the required distance away from the stationary arcing contact and air blast orifice (13) drawing an arc between the contacts. As the tubular stationary contact is the only outlet for the compressed air, a blast of high velocity air is simultaneously impelled across the initial arcing zone, resulting in limitation of arc energy release and preventing reignition after the first current zero.

Simultaneously with the admission of air to the interrupting chamber, air pressure is applied to piston (9) resulting in opening of the disconnect contacts (5) under no load, as soon as arc interruption is complete.

The air required for arc interruption causes pressure in the breaker tank to fall. Since this tank is permanently connected to a compressed air storage system, the supply of air within the tank is quickly replenished.

For interrupting capacities of 150,000 kv-a. and higher these breakers are usually equipped with paralleling resistors. These resistors are wound noninductively around the muffler. As the arcing contacts separate an arc is drawn between them and the centralizing action of the air blast forces the arc into contact with a probing electrode, thereby automatically inserting the resistor in parallel with a portion of the arc during the first half cycle.

Conclusions

This concludes the general description of these three new air blast circuit breakers developed by American manufacturing companies. They all represent distinct advances over previously developed European types and all effectively meet the severe requirements of American practice. They can be applied practically over the same range of interrupting capacity steps and voltage as oil circuit breakers and the future will undoubtedly see many applications of the breakers. On tests they have complied with all the requirements within the limits of their rated capacities, with outstanding success.

[3]Circuit Interruption by Air Blast A.I.E.E. Technical paper 40-66. By Messrs. W. S. Edsall and S. R. Stubbs.

Do you have occasion to make periodic tests of electric motors? If you have motors under your care, you have, and then by all means you should read this article. Mr. von Dannenberg is no newcomer to these pages; he was a frequent contributor in the good old days, B.D. (Before Depression) and since then it has been his lot to operate plants in remote parts of the world, far removed from easily accessible sources of supply and he had to depend upon his skill and ingenuity for the solution of the many problems that came to him each day. This business of motor testing was one of them and he tackled and solved it with the fine skill that implies a thorough training in engineering.

Motor Testing Simplified

By C. O. von DANNENBERG

THE subject of routine testing of electric motor equipment is always a pertinent one.

The tests for insulation resistance are comparatively simple in performance but give in only a qualitative form of information concerning the condition of the equipment, while tests showing power consumption, and other electrical operating characteristics, at various loadings, enable closer checks to be kept.

As usually conducted, the tests require some skill as well as experience and judgment to obtain reliable information. This is particularly true when testing AC, 3-phase motors and the details given hereafter apply particularly to this type of equipment.

The simplest tests, made in a conventional way, and without instrument transformers, will require three meters at least, namely a voltmeter, an ammeter and a polyphase indicating wattmeter or four meters if single phase wattmeters are used. At the same time, to be assured of the values of current and voltage to be used, provision, through suitable switching facilities, should be made for reading the three line currents and the three voltages between the lines, to obtain average values to be used in calculating the power factor and volt-amperes (or kv-a.)

Experience indicates that even with the greatest effort and when several observers are available, it is not unusual to obtain power factors greater than unity (100 per cent), particularly when the load is fluctuating. The reason for this is generally due to a high reading for the wattage and low readings for the average amperes and volts so when the power factor is calculated the further multiplication of the volts and amperes by the $\sqrt{3}$ factor increases the error.

It seems therefore worth while to give consideration to a method which will reduce to a minimum the equipment required, simplify the conduct of the tests and make possible results without sacrifice of accuracy.

The writer, faced with the necessity of conducting such routine work, where the personnel available was virtually untrained, as well as being indolent and careless, used the methods described hereafter which may be of interest to others.

The essential difference in the method of test is in the use of watthour meters in conjunction with an electrically operated timer. Tests indicated that, in general, motor circuits were sufficiently balanced to justify using this method which consists in the use of two meters and a timer. A check of the three currents was made with a clamp-type ammeter which showed at once whether the currents were at all unbalanced.

The watthour meters were either of the rotating standard type or standard meters equipped cyclometer dials arranged to read directly the revolutions of meter element.

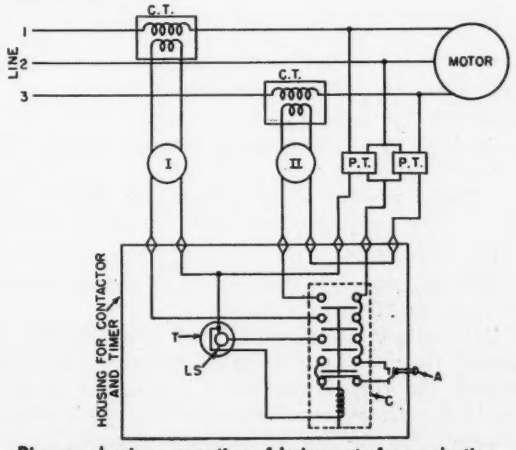


Diagram showing connection of instruments for conducting motor tests

The timer was of the synchronous motor type and could be read to 0.01 (1/100) of a second, although routine tests indicated that readings to 0.1 (1/10) of a second was sufficiently close for the greater proportion of the tests.

The actual testing operation was very simple since provision was made at each test point for connecting the testing instruments, either directly to the circuit or in conjunction with current and voltage transformers. Each meter was provided with a short-circuiting device for the current element. The appended diagram gives the essential features and connections, omitting certain protective equipment. As indicated, there is included in one housing a contactor "C" and timer "T"; by means of push button "A" the two meters and the timer were started simultaneously and continued until the timer limit switch "LS" stopped the test at the time-setting made. Actual instruction enabled the testers to assure themselves of the correctness of the connections to the circuit and this was further simplified by having all meter and instrument transformers plainly marked as well as providing diagrams with the connections marked in different colors.

With a motor operating, the meters were started and tests made through different time periods, as per instructions, and depending upon the operating features of the particular motor undergoing test: The tester simply recorded the readings of the meters at the beginning and termination of each test together with the time interval of the test.

It is obvious that the difference in the readings, in revolutions, is a measure of the kilowatt hours used during the time interval and knowing the constants of the meters the actual kw. inputs can be calculated by conventional methods. Actually the tester simply recorded the data for a number of specified test conditions while the actual calculations were made at the chief engineer's office:

Given the two readings in kw. (or watts) of the test meters, which we will designate W_1 and W_2, W_2 being the greater, it is possible to calculate values as follows:

1. Total watts (or kw.) input as $W_1 + W_2$.

2. Power factor (percent) is $50\sqrt{\frac{(1+A)^3}{1+A^3}}$

where A is W_1/W_2.

3. Total volt amperes (or kv-a.) are $2\sqrt{W_1^2 + W_2^2 - W_1W_2}$.

A check of *3* can of course be made by dividing *1* by *2*.

4. Total reactive volt-amperes (or RKVA) are $\sqrt{3}\ (W_2 - W_1)$

It is of course possible to arrange *2* in other forms but the one given has been found easiest, to remember and handle, from experience.

Calculations of power factor were facilitated through the use of curves based upon values of "A" through the full power factor range. It is clear that if the power factor alone is required it is only necessary to use the actual meter speeds for its determination.

The calculation of W_1 and W_2 was further facilitated by taking the product of the ratio of the actual speed of the meter, per unit time, to the full load speed of the meter times the full load rating of the meter. This method, makes unnecessary, when once determined, the need for any meter constants or factors other than those concerned with the instrument transformers. A careful calibrating check of the meters through a wide speed range was found desirable to assure accuracy.

The method as outlined indicated desirable features as follows:

1. The number of test instruments required is reduced to a minimum.

2. The readings are accurate since the watthour type of meter is inherently accurate.

3. The readings are accurately recorded automatically and do not depend upon the visual acuteness or judgment of the tester.

4. Since any test is made up of an average of certain readings, the average by this method is based upon an accurate summation not possible to obtain when indicating meters are used. This is particularly true when the load is fluctuating.

5. Power factors exceeding unity are never obtained by this method.

6. Errors are reduced to a minimum since the recorded data consists, simply in taking two readings which are readily available and definite.

7. The equipment is standard and can be modified or adapted to any particular situation.

There is the possibility of adding to any watthour type of meter a direct reading demand indicating device but this would require that the tests be held to one fixed time period or some means arranged, not readily available, to vary the time interval at will. In the writer's experience it seemed more practicable to set the time for any interval desired.

The method described is based on well known principles using equipment readily available. The contactor shown as well as the timer could have been omitted although for the situation where it was used the results obtained through the better control afforded justified the inclusion of these features.

It is of interest to note that the power factor obtained by this method even with unbalanced conditions compared favorably with with laboratory methods and while this method of calculating power factor is well known it is considered that its application, to this purpose, has not been as generally made use of as its merit entitles it to be.

IN ANNOUNCING the second price reduction of the year for aluminum, bringing it down to 18 cents a pound, Roy A. Hunt, president of the Aluminum Company of America, stated that this course is made economically possible through the benefits of research and development together with the expansion of plants and facilities for the production of this metal. It is the intention of the company to share such economies with the consumers of aluminum.

The PRACTICAL ENGINEER *and* ELECTRICIAN

RALPH E. TURNER, EDITOR

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NOT PERSONAL

In a letter addressed to the attention the editor, a prominent manufacturer writes: "We have followed with considerable interest that section of your journal titled "The Practical Engineer." Since its inception we've silently applauded the idea and the fine manner in which it's been handled. Now don't puff up personally . . . . your associates were good too." There is a bit of philosophy in this last remark that every man should take to heart. No matter what a man's talents may be, his success rises or falls with the character and ability of his associates, for in this complex society of ours the master of all trades or professions just does not exist. Each of my associates has outstanding talents which I do not possess. Fate has ruled that we have been thrown closely together in producing a product that demands the talents of us all, so that no one of us has a right to claim, or does, that his contribution is the all important feature of the product. Our friend was applauding us as a staff rather than any individual editor—a fine distinction which characterizes the sincerity of his statement. Our thanks are extended. **R. E. T.**

A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

For Practical Engineers

The articles chosen for presentation in this group illustrate the broad scope of the practical engineer's work. They deal with processes, instruments, equipment operation and mechanic arts. The practical engineer, as we know him, may be defined as a particular type of economist—one who expends or directs the expenditure of money, time, labor or energy judiciously and without waste through the application of science.—Editor.

Candy Engineer

By P. H. Keeney

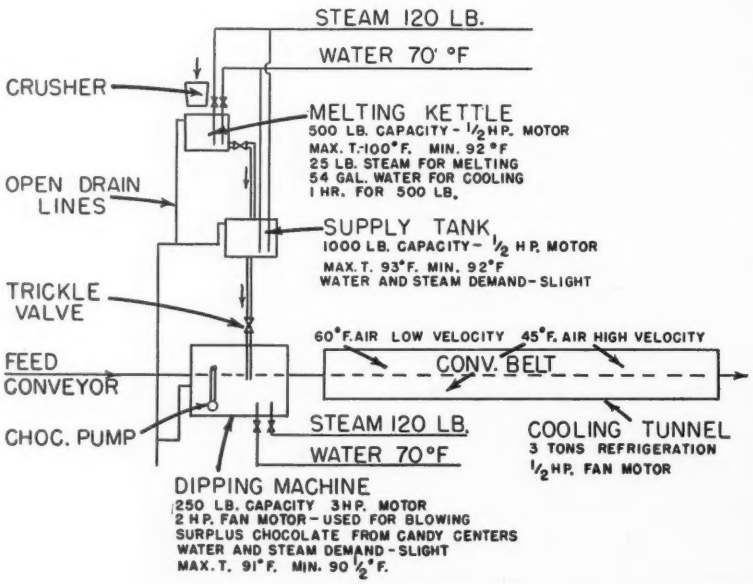
CHOCOLATE COATING is one of the most touchy candy ingredients in use. It is received from the chocolate manufacturer in 10 lb. cakes which are fed through a crusher into melting kettles. These are agitated steam jacketed cast-iron kettles having a capacity of from a few hundred to several thousand pounds. Just let a water or steam valve do a bit of leaking here and your griefs start.

The melting rate of the chocolate is very important. If too fast the temperature of the chocolate is too high. This disturbs the fats in the chocolate and the finished goods will be below standard. If the melting is too slow, the whole chocolate room crew will be standing around waiting for chocolate.

From the melting kettles the chocolate passes to the supply or storage tanks, usually holding two or three times the melting kettle capacity. They are agitated and steam jacketed and the temperature is held one or two degrees higher than the dipping temperature. You can almost be sent to jail if you allow a leak to develop on one of these tanks.

Then to the chocolate dipping machines. These machines have a capacity of from 150 to 300 or 400 lb. of melted chocolate and pumps for pumping the chocolate over the candy centers which pass through the machines on a wire belt. Chocolate in these machines must be held within one fourth of a degree of the correct dipping temperature, and properly tempered. The chocolate from the supply tanks is allowed to trickle into the dipping machines as consumption demands. A very important step lies in keeping the chocolates at the right temper. Agitation is very slight. Too much agitation and the lowered temperature raises the viscosity of the chocolate, increases the per cent of chocolate on the centers, and makes the big Boss foam at the month. Too high temperature here is also bad for when this happens the chocolate will not dry when it passes through the cooling tunnel which comes next in our line of travel.

When the freshly dipped chocolates leave the wire belt onto the glazed surface belt of the cooling tunnel it is of major importance that the refrigerated air is controlled properly in the tunnel. Under the belt and at the delivery end of the tunnel the air temperature can be very low and the air flow at a high velocity, but from about the center of the tunnel to the machine end the temperature should be 15 to 20 deg. F. higher and the air flow at a much slower velocity. This condition, along with a low relative humidity, will result in a finished piece of candy that will have high gloss, long shelf life, and when eaten will melt in your mouth.



A Fuel Conservation Engineer's Pets

By J. C. De Foe

ITEM 1. For the users of Junker type gas calorimeters. If you will sacrifice a little accuracy for speed, the box shown by Fig. 1 will help to eliminate weighing the water. Have a heavy sheet metal box made with 12x12x12 in. inside dimensions and a plate soldered near the bottom, drill this plate and tap for ½ in. brass water gage valve (upper). Put in gage glass long enough to reach the top of the box, then drill and wire a section of meter stick to the gage glass.

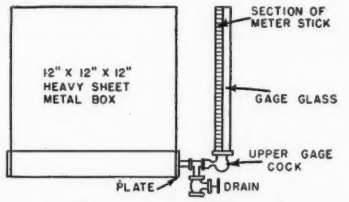


Fig. 1. This calibrated box replaces the weighing buckets now in use on most gas calorimeters

Fill the box until water reaches the bottom of the valve. Add water, 5 lb. at a time, reading each height on the meter stick. Plot the weight of water against millimeter's height on the scale to provide a calibration chart for the box. There's lots of uses for a calibrated vessel besides using with a gas calorimeter.

ITEM 2. Protect the Orsat leveling bottle. Figure 2 shows a convenient and simple protection for the leveling bottle. The metal band at the top should

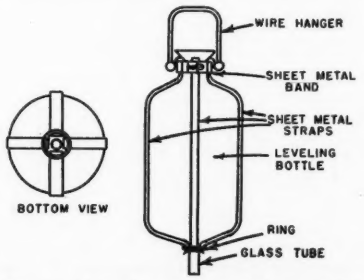


Fig. 2. Method used to protect the Orsat leveling bottle

have the ends bent out at right angles, drilled and fitted with a small bolt for locking on the bottle neck. In the case of flat bottom leveling bottles, the straps should be crossed on the bottom and held together with a small rivet.

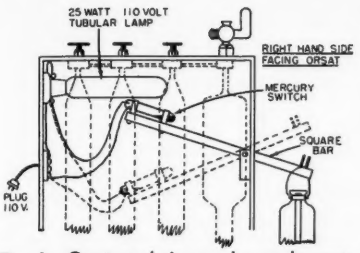


Fig. 3. Orsat analysis can be made more conveniently with proper lighting. Flash light bulbs and batteries can be used instead of 110 v. if desired

ITEM 3. Let's throw a little light on the Orsat. Dark corners and basements slow up the running of analyses on flue gas samples but this can be corrected easily by the arrangement shown by Fig. 3, using a tilting bar carrying a small mercury switch. The dotted line shows the position of the square bar when the bottle is off during manipulation of the flue gas sample. The light is on only when the bottle is off of hook. If 110 v. sockets are not handy, the same set up can be used, replacing the 25 watt lamp with two flash light bulbs (one behind pipettes and one behind burette) and using either flash light batteries or dry cells.

ITEM 5. Miscellaneous. a. When looking for leaks around equipment (either pressure or vacuum) where it's dangerous to use a flame or smoke, two beakers, one containing hydrochloric acid and the other aqueous ammonia can be used to an advantage. By holding the beakers close together near the suspected leak, the white particles will indicate whether there is a leak or not.

b. Prestone can be used to an advantage in the U-tube seals on draft gages exposed to the weather. It can also be used to winterproof the Orsat water jacket and expansion chamber.

c. Half water and half glycerine, slightly acidized with sulfuric acid (if you want to keep on living *don't* use nitric acid) works very well in the leveling bottle and burette of the Orsat.

d. Wrap the oxygen and carbon monoxide pipettes with friction or adhesive tape. This will protect the solution from break-down by light.

e. A long piece of gage glass is mighty handy to grab flue gas samples where the temperature is too high for standard pipe. (Watch out for the oxidation of standard pipe in sampling.)

Prevent Pulsations in Compressor Piping

By S. H. Coleman

SEVERE PRESSURE PULSATIONS in air compressor discharge piping cause noise and vibration and are frequently responsible for an increase in the power, requirements. In almost every instance pulsations of troublesome magnitude are either caused by inadequately sized discharge lines or by surges resulting from resonance in the piping. These difficulties can be avoided by properly designing, or by remodeling, the piping joining the compressor with the receiver.

Discharge pipe capacity must be sufficiently large to transmit the air without excessive pressure loss. Since the discharge from an air compressor cylinder occurs during about one-half stroke in the case of a two stage unit and for about one-quarter stroke when a single stage machine is used, piping design must take into consideration the total volume of air handled and also the flow characteristics. Where length of line and number of fittings are not excessive the recommended minimum discharge pipe sizes when transmitting air at 100 lb. pressure are:

	Rec. Min. Pipe Size, in inches	
Comp. Cap. C.f.m.	1 Stage Comp.	2 Stage Comp.
0- 100	2	1½
100- 200	3	2
200- 300	4	3
300- 400	5	3
400- 450	6	3
450- 500	6	4
500- 900	—	6
900-1550	—	6
1550-2400	—	8

The presence of an aftercooler near the compressor discharge to cool the air and remove excess moisture, dust and oil will often correct an otherwise poorly designed piping layout. Cooling reduces the volume of air going to the receiver and since the usual aftercooler is baffled and has considerable air storage capacity it tends to smooth out velocity fluctuations in the rest of the line.

Surges are caused by the length of piping between compressor and receiver or between compressor and a right bend in the line having a pulsation frequency in resonance with the frequency of high pressure cylinder discharge. When this occurs pulsation waves returning to the cylinder at the instant of valve opening cause a building up of pressure during part of the discharge cycle thus increasing the work required to deliver the air. Where piping is sufficiently large and power requirements seem to be excessive such a reasonate condition may be responsible.

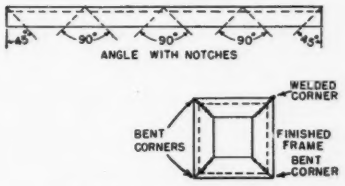
If suspected, the existance of surges can be easily determined by taking an indicator card from a connection on the line by means of a standard engine indicator. Where surges are experienced they can be damped out with surge chambers installed near the compressor discharge. A short section of pipe capped at one end and screwed into a tee in the discharge line is ideal for this purpose. Long radius bends should be used wherever possible in air lines between compressors and their receivers. When a short radius turn must be made near the high pressure cylinder, a tee with a surge chamber having a volume equal to at least half that of the cylinder should be used instead of an elbow to avoid any possibility of resonance. Commercial silencers installed in the discharge line are especially effective as a means of eliminating both pulsations and resonance and blotting out undesirable noises incidental to compressor operation.

Angle Iron in Welded Machine Construction

By John E. Hyler

AS TIME goes on, it is becoming increasingly evident that angles are one of our most convenient standard shapes for various types of welded machine construction. One reason is that an angle iron is inherently strong for the amount of metal it contains in cross-section, and another reason is the facility with which it lends itself for the purpose. Where it is used in considerable quantity, it is readily possible to equip for speeding the process to a high degree.

As a case in point, consider in how many places logical use is found in machine design for angle iron bent into circles or into segmental forms. In days gone by, such bending would have offered difficulties indeed, in order to get a really smooth and workmanlike job. Now, however, heavy bending rolls are available which handle angles and bend them in the plane of one of the legs without any difficulty whatever. The rolls are grooved in such manner as to allow one leg of the angle being bent to house itself in the groove. Thus a full and positive bearing is obtained and the work is adequately held in the process of bending.



Angle iron cut, bent and welded into square frame

By cutting a 90-degree wedge or pie out of one leg of an angle at a given point, a square bend may be made therein, and the meeting edges of the gap will close in the process, in proper position for welding the square corner thus formed. It will be seen that it is readily possible to make up a square or oblong frame in this manner from one long angle, so that there will only be one full butt joint in the assembly to weld. There are many places where such a process is highly convenient, and in some places a combination angle iron machine is used which shears the angle, makes the necessary notches and then bends it. This is all done at a very satisfactory rate of speed, worthy of any production line. Simple angle iron shears are also available, which allow the speeding of angle iron operations over the use of a cutting torch.

The designer of light-weight machinery in particular, where welding is being used as a fabrication process, will do well to watch the possibilities of angle iron as he goes along, both for its individual structural advantages, and for the combinations that can be worked out with other shapes and materials.

FOR THE PLANT ELECTRICIAN

Essential Equipment for the Electrical Department

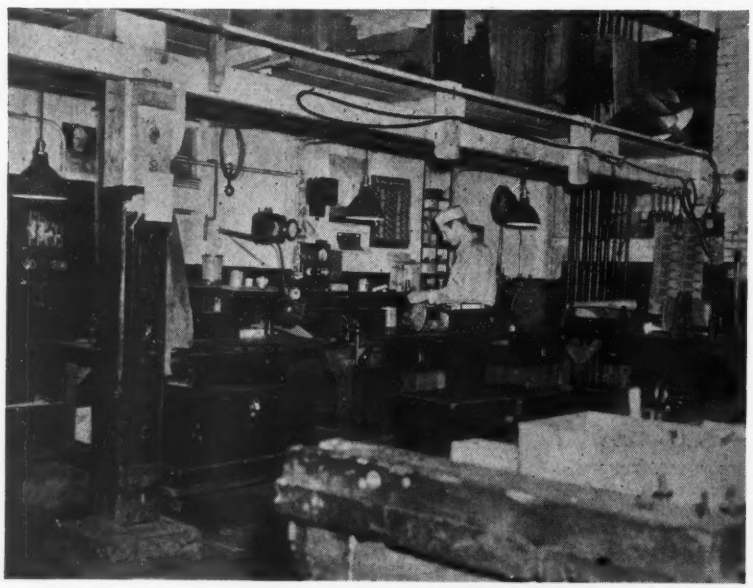
By C. C. Hermann

IN GENERAL, managers of industry readily recognize the importance of equipping the electrical maintenance shop with efficient tools required in the performance of maintenance duties. There are, however, glaring examples of inefficiency in many plants in this respect. No electrician can perform his work without efficient tools in an efficient and thorough manner any more than the accounting department can insure accuracy and efficiency in maintaining the accounts of the business without adequate equipment. Just as the adding machine, the bookkeeping machine, the teletype, the dictaphone and the pencil sharpener are essentially necessary in the office so are the voltmeter, the wattmeter, the ammeter, and the megger essential instruments in the electrical shop.

In Fig. 1 is shown a very well equipped electrical shop in one of the largest sporting goods manufacturing plants in the country, that of A. G. Spalding & Bros. Company located at Chicopee, Mass. Not only are all of the essential instruments on hand in this shop but the interior arrangement of the shop is bordering on the ideal. The work bench is well located and well lighted. The under space is kept clear of all material usually found beneath benches. A place has been provided for every item of equipment and they are kept in their alloted place.

The walls, columns and equipment of a permanent nature are kept well painted. Floor is kept clean and orderly and tool chests are mounted on platforms provided with castor wheels so they may be pushed beneath the work bench when not in use. This same device permits the tool chest to be pushed to the job without wasting time looking for a shop truck.

There are certain tests which are essential to the reduction of electrical maintenance such as lamp tests. It is remarkable, in spite of the fact that electric lamp bulbs are very well standardized, to note the variation in lamp life as between different makes, even between different shipments of the same make. Here a continuous lamp test is carried out and the total number of hours of life for the lamp is recorded. Likewise there is a variation in the efficiency of motors due to variations in voltage impressed on the power lines. Here a voltmeter is kept in the circuit at all times to record the voltage, the record showing any and all variations. Power factor affects the demand rate and the contract calls for a minimum of 85 per cent. Any drop below this figure results in a penalty charge. A power factor recording meter is kept on the line to indicate all fluctuations in this factor of electrical operation. The plant is operated on a time system involving a series of electric clocks operated from a master clock. The electrical department is responsible for the maintenance of the correct time by these clocks, therefore a clock connected in the system is kept in the electrical department.



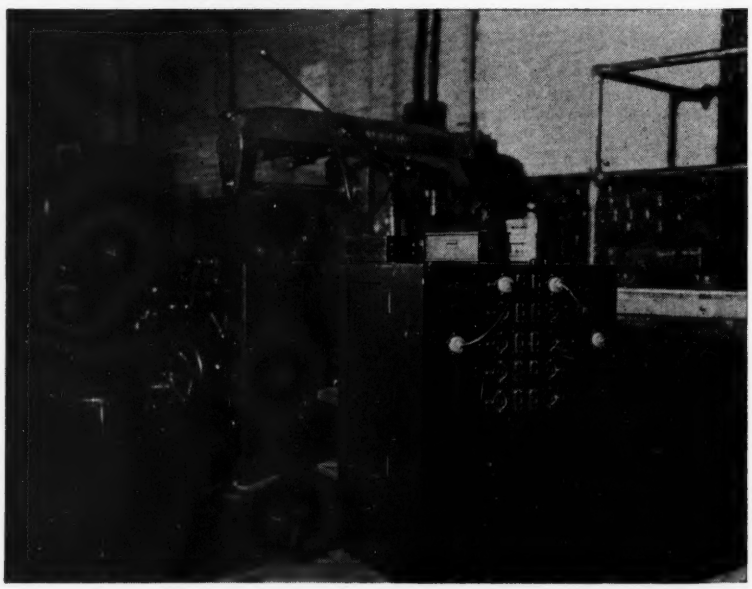


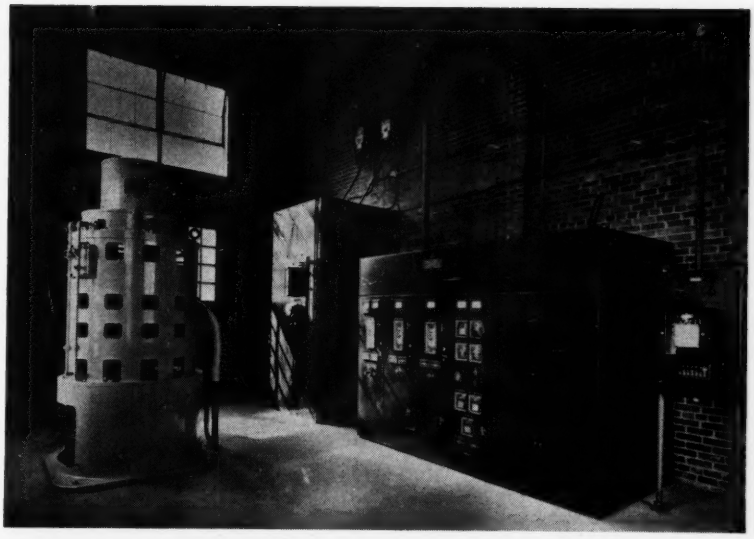
Fig. 1. (Above) A well planned and fully equipped Electrical Department is an asset to any plant

Fig. 2. (Right) The cabinet shown here provided with wheels for easy movement and doors provided with locks makes testing in any part of the plant an easy and safe function

There are many tests which must be made with electrical instruments at different points throughout the shop. The way this is handled at Leeds & Northrup Co. in Philadelphia, Pa., is by means of a mobile truck shown in Fig. 2. This truck, provided with a steel cabinet and all the necessary instruments is moved direct to the part of the plant where the test is to be made. Perhaps it is a motor which appears to be overloaded. The recording wattmeter is plugged in on the starting box of the particular motor and the necessary leg connections are made through the wattmeter. The instrument is not removed from the truck cabinet at all as receptacles have been provided in the end of the cabinet for the plug connections. The instrument is left on the line for the required length of time and usually the entire story of motor operation is given on the chart at the end of the test. Perhaps it is desired to check the voltage separately. This is easily done by taking the two leads from the voltage taps to the live side of the starting switch. If it is an ammeter test, the split coil is placed around one of the motor leads and, knowing the ratio, the amperes flowing may be read direct.

Much depends on the ability of the electrician to make his readings easily and without the necessity for him to jeopardize his health and even his life. Provided with the right type of equipment and safe guards the tests will be accurate and thorough. On the other hand if it is necessary for the electrician to fuss around with a series of lengthy wires making connections here and there and having his equipment scattered around on the floor, on parts of the machine or even hanging on some machine member of the reliability of the test results becomes questionable.

Recording wattmeters, voltmeters, ammeters, meggers and other electrical testing equipment involves considerable investment. In some plants ten to fifteen thousand dollars are invested in this type of equipment. It is obvious that such expensive instruments cannot be left laying around the plant, even though a given test may involve from one to ten days to obtain the desired data. The fact that the cabinet is provided with doors which may be locked makes the protection of instruments against damage and thief complete. The cabinet may be located adjacent to the machine and connections made thereafter allowing the instruments to function uninterrupted.



Flood Protected Pumping Station

Covington, Kentucky, has replaced its old pumping station inundated during the 1937 flood, with a modern plant so constructed that no floods, even 12 ft. higher than the record 1937 flood, will cause any interruption in the important service. An 800-hp. vertical synchronous motor for the new turbine pump, with a capacity of 10,000,000 gal. per day, and all the indoor electrical switch equipment is housed on the second floor of the new building, the upstream side of which is reinforced to withstand the impact of large and heavy floating bodies. The pump has a capacity of 10 million gallons a day against a total dynamic head of 390 ft.

Three phase, 230-v., and single, 115-v. station service for auxiliary station power and for lighting is obtained from a 30 kv-a. 13,200/230-115 v. transformer bank located in the new outdoor substation.

Metal Spraying Saves Expensive Replacement

By John E. Hubel

One of the largest electric power plants in the state of Wisconsin is that of the Wisconsin Electric Power Co. On one of its direct current generators a flash-over occurred, leaving a hole the size of a dollar and about ⅛ in. deep. This ordinarily means turning down the commutator, no easy or inexpensive job on one that is more than 4 ft. in diameter. That is the course ordinarily pursued in any power plant under similar circumstances. But a new industry that has grown up in recent years has found a way to make such repairs at little more than half the cost of turning down a large commutator, and in a much shorter time.

This is the metal spraying industry, now developed to a point where there are no failures, and which has made it possible to repair expensive power house and other machinery, making replacement unnecessary. In the case cited, the commutator with a hole burned in it was metal sprayed by a company that specializes in this work. The hole was filled with copper with a little excess metal, so that only a very slight turn was necessary to assure a perfect surface. Cost of the work, about $138, as compared with about $225, if the commutator had to be kept out of service in order to have about ⅛ in. taken off the entire surface of the commutator, according to W. E. Gundlach, in charge of electric plant maintenance for the Wisconsin Electric Power Co.

The metal spraying art is now rather well known, but the enormous savings effected with the use of this art are not sufficiently realized, it is believed, by many operators of large machinery, which may need replacement of worn parts after long service. A case in point is that of an electric power plant in which a large unit had been operating for about 20 yr. bearings in a steam engine had been relined or replaced frequently, but the time came for having something done to the shaft itself, as this was beginning to show considerable wear at the bearings. The engineer relates that, having heard of the work of a metal spraying company in salvaging shafts that appeared to be about ready for complete replacement, decided to get authority to have the shaft of his engine metal sprayed with material that would give a bearing surface that was even better than that in the shaft when it was cast and machined. It was also learned that the shaft, which was a heavy one, would not have to be taken out of the engine, but could be sprayed on the job.

Metal spraying experts were called upon to do this work, applying metal at the shaft bearing a little oversize, so that when turned down it would have exactly the right diameter. This work was done months ago. An interview with the engineer on the job elicited the information that the engine, when properly lined up after spraying and machining, with new bearings, has been operating as it did when it was new, so far as the bearing surfaces are concerned.

Other expensive power house machinery, ordinarily in line for replacement, due to excessive wear on major parts, have been found to be reclaimed and made practically as good as new so far as efficiency in operation is concerned, after having had the worn parts metal sprayed and remachined to proper fits.

How Would You Do It?

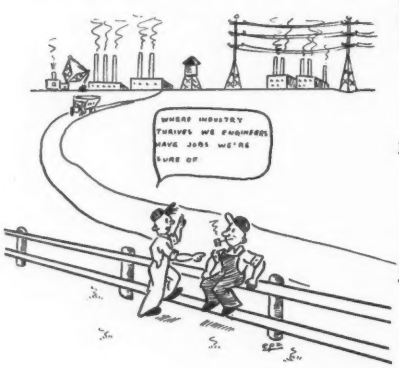
Putting a new 25,000-kw. turbine plant into operation, Our Hero has found, involves a high degree of skill in handling personnel. He was made aware of this fact when he found that the city of Glendale, Calif., failed to secure a sufficient number of applicants for civil service examinations leading to positions as Chief Engineer and Watch Engineer on the first posting of the notice. Our Hero appealed, in the July issue, for ideas that would help him to select and secure the best men available for these positions.

PROBLEM II

Engineers Wanted

MERCY on us judges of this contest! Our Hero had a problem, a common every day problem, he just wanted to hire two top notch men to operate his new turbine plant. There is nothing strange, startling nor unusual about that. He found that a municipal plant was using a method that did not hit the ball the first time it came over the plate, so he calls for suggestions. Now he finds that there are so many criticisms of the Glendale method and so many other better methods that the judges of this contest are tempted to call in the Supreme Court of the United States to decide the points at issue, knowing full well that its decision would be no more correct than our own but we would at least have some place to pass the buck.

Problem II has two parts — what is wrong with the Glendale proposal and how should Our Hero proceed to solve a similar problem. The judges find that the contestants put more stress on criticism of the Glendale proposition than they did on helpful suggestions to Our Hero. Several things were made evident: Engineers do not like civil service examinations. They do not like to work under political domination. They want jobs where service and ability are rewarded with promotions and security of positions. They think they are more economically secure in the industrial centers of the country than in decentralized districts. They prefer to work in privately owned plants. They want a high standard of living for their families — schools, libraries, playgrounds, churches, employment possibilities, healthful surroundings. They believe there is a shortage of really skilled workers. They believe chief engineers and superintendents want to see worthy men under their employ progress, even though that progress leads them to positions outside their organization. From all this we may rightly conclude that power engineers consider their jobs as long lasting connections that should be broken only under deep, irremediable dissatisfaction.



First prize in this contest goes to Mr. Biggs because his answer covered the most essential reasons why engineers may not have applied, and also gave Our Hero helpful suggestions for attracting applicants for positions he has to offer.

FIRST PRIZE AWARD

L. R. Biggs

Schenectady, N. Y.

ABOUT A YEAR ago a somewhat similar proposition was placed before me and at that time I made the following list of the advantages and disadvantages of making such a change, and I would like to submit this summation.

1. There are likely to be political angles, in spite of the civil service, which engenders a vague fear that all may not be smooth sailing after the position is obtained.
2. To a person who lives in the East and who has read of the huge development of hydro-electric power within transmission distances of this area, it is a mystery why a steam plant should be necessary.
3. There are vague fears that the plant may prove uneconomical and be abandoned or relegated to standby service. There is the fear that the Federal Government may decide to provide firm power sources by building steam plants of its own.
4. There is the question of obtaining an operating license. A license used by one state may not be good in another.
5. A man to satisfactorily fill this position should have 10 to 15 yr. experience, and due to the demands on his time as a chief, he may feel that his technical theoretical knowledge has been neglected and would have some fears of being able to pass an examination. This means that a chief's job is concerned with keeping the plant running from the standpoint of scheduled maintenance, coordination among his personnel, obtaining fuel supplies, and other routine matter. There are many sources of obtaining necessary technical data which may be required in the course of running a plant. An engineer who has grown up with a specific power plant knows it thoroughly, but he might not be able to pass a civil service examination conceived by someone in another part of the country.
6. Most companies have insurance benefits, pensions, vacation plans, priorities for advancement and for continuous employment that would be completely lost by a change. The applicant would have a family of one to four children of ages between five and sixteen. The family would have social ties in connection with everyday life, so it would be difficult to obtain the consent of the family to make such a move.
7. An oral examination means a trip to California, and as most of the sizable steam power plants are in the East, considerable expense would be incurred and working time lost. Possibly no time could be obtained to make such a trip and there would be no incentive to ask permission to go, as there would be no assurance of obtaining the job even if the trip were made.
8. Negotiations for a job of this kind cannot be carried on without the cooperation of the applicant's present employer. It would be difficult and embarrassing for anyone to explain to his superiors why he was trying to get a job in a different locality.
9. If the applicant finally succeeded in obtaining the job, and after two or three months it was found that he was unsatisfactory, he would be stranded in the West where steam plants are comparatively few.
10. For the risk that a person would have to take, the salary is too low to be attractive. It would cost from $500 to $1000 to move and so would take several years to make up the loss.

There are other reasons which would apply to each specific case, but those enumerated are so outstanding that they seem to fit practically all cases. It would help if some of these things were explained, possibly by a bulletin which could accompany the application blanks or by

advertising in connection with the filling of these positions. Specific suggestions would be as follows:

1. An explanation of how the plant came to be built and located where it is, also the future possibilities of expansion with some idea of the number of kilowatt-hours generated each year, the use factor of the plant, the type of fuel burned, and other information which would be of interest to an operating engineer.
2. An outline of the requirements for obtaining an engineer's license in the State of California would help. The states in which there are reciprocal agreements should be given.
3. A set of sample questions should be sent to the applicant. The questions should be confined principally to that of personnel and of operation and not to specific technical questions. An oral examination in California should not be requested. The board should line up possible applicants and visit them personnally, thus eliminating traveling expenses and avoiding the necessity of the applicants obtaining time off.
4. Any insurance benefits, pensions, etc., which are available should be mentioned. The advantages of living in California could be stated and an idea of the cost of living would be of interest.
5. Negotiations could be made with executives of some of the utilities in the East. Most companies do not stand in the way of advancing their men, even though they are lost to the companies' services. It would be less embarrassing to the operator if the opportunity came through his own executives.
6. A guarantee of continuous employment for a period of five years would be desirable.
7. An offer to defray the traveling expenses of the man and his family to get them settled in a new locality would be attractive.

In one particular case, the tax situation was significant, in that although an increase in salary was offered, it was ineffective due to a different system of taxation.

SECOND PRIZE AWARD
Harold D. Brown
Chicago, Illinois

FROM THE MANY articles appearing in magazines and newspapers the question of how to find men to fill responsible positions seems to be troubling more than just power plant men.

If the Glendale plant offered from $500 to $750 per month for chief engineer they would be more likely to get enough applications so that they would be able to pick the man they want for the job.

A man with the experience and the ability to manage the personnel connected with a civil service position in charge of a 20,000-kw. generating plant would most likely have a position paying more than the Glendale job and if it does not he will feel fairly secure and not care to take a chance on changing jobs.

Most engineers feel that there is not sufficient opportunity for advancement nor the use of initiative, and that there is too much politics connected with a civil service position to waste their time taking the examinations.

Probably, another reason that the Glendale Commission did not get more replies is that the notices were posted in places where most engineers do not go more than once or twice a year such as the post office, civil service rooms and union halls. They will probably be swamped with replies from the notice in POWER PLANT ENGINEERING.

If Our Hero wants to secure men of outstanding ability he should; First: Advertise the position in places where men who are not looking for another job will see the advertisement.

Second: The remuneration should be sufficient to be attractive to men of the necessary experience and ability.

Third: The company should have a reputation for keeping its employees.

A help wanted advertisement for an important position should be put in a display advertisement in the reading section of a trade magazine where none of the readers would miss seeing it.

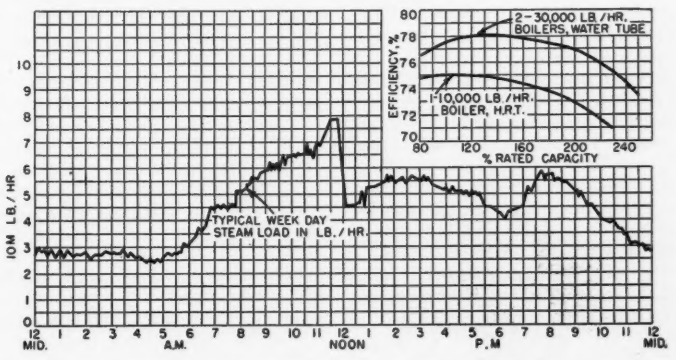
The Glendale Civil Service Commission has done an excellent job of summing up the necessary qualifications for a chief engineer in their Official Bulletin, "(*Special Qualifications Required*: A thorough familiarity with power plant equipment, operating practices, methods of operation, control and maintenance. Methods of selecting fuel and mechanical engineering principles applicable thereto; familiarity with the requirements of the boiler safety orders of the Industrial Accident Commission of the State of California; familiarity with the A. S. M. E. boiler code; ability to lay out the work of others, to direct them in their work and get them to work together effectively; ability to size up situations and people accurately, to adopt an effective course of action, and to get along

PROBLEM No. 12
BOILER OPERATION SCHEDULE

Until about a year ago, Our Hero had no difficulty in scheduling the boilers in his municipal electric power plant, but now the load has increased and he is expecting it to keep on growing for some years to come. Heretofore he has been using his h.r.t. boiler from the late evening until noon the next day, starting one of the water tube boilers in the morning when the load became too great for the h.r.t. unit. Under former load conditions, one of the w.t. boilers could carry the load through the afternoon. This schedule worked out very nicely with one boiler to spare at all times. When necessary to repair the h.r.t. boiler a w.t. unit took its place. It is found now, however, that the afternoon load crowds one of the w.t. boilers to about 200 per cent rating, which is not impossible but very close to the allowable limit for the equipment available, and the growing load has Our Hero puzzled as to how he might schedule his boilers to secure the highest operating efficiency and at the same time be assured of sufficient steam at all times when the load has increased, say, 25 per cent above its present typical week day condition.

The water tube boilers are equipped with forced draft traveling grate stokers and respond quickly to changes in load. A single retort underfeed stoker serves the tubular boiler which is slow to respond and gives clinker trouble when operated over long periods at ratings above 175 per cent. He thinks the accompanying curves and the data given are sufficient for the satisfactory solution of the problem.

For the best solution to this problem and the reasons backing it, confined to about 700 words, a prize of $15 will be given, second prize $10 and third prize $5. All entries must be in the office of Technical Publishing Co., 53 W. Jackson Blvd., Chicago, Ill., by September 25 in order to be considered by the judges. Address entries to the attention of the Contest Editor.



well with others; integrity; initiative; accuracy; resourcefulness; tact; thoroughness; good judgment; good health and freedom from disabling defects.)"

A man with these qualifications would not be found among the unemployed and it is not likely that he would be looking for a different position, therefore, it would be necessary to reach him through an attractive offer or through his friends.

THIRD PRIZE AWARD

Homer H. Crider

Yosemite National Park, Calif.

FORTUNATELY for many of us, Our Hero likes to take the rap for our brainstorms. He lives to tell the tale and, in fact, comes back for more.

Suppose that, for the subject under discussion, we simply refresh our memories on a few facts which must surely have been previously known. The following premises will therefore become the meat of this article.

1. Real money must be expended to train a steam plant watch engineer.
2. Experience is the main qualification for the job.
3. There is available practically no surplus of qualified men.
4. Civil service, in so far as employment needs are concerned, is in an especially considered category.

Under the heading of the first premise quoted above, must be stated the fact that private industry regularly provides training for their own replacements. They may be called apprentices, understudies, junior watch engineer, and some industries bolster the training by providing special technical schools. For one reason or another, many fall by the wayside and logically, a man, outstanding in this profession, is welcome indeed.

In the second premise, the single sentence is sufficient; for the truth is apparent. It is analogus to that of locomotive engineer;—an old head, an experienced man. Still it might be well to mention that of the many schools which endeavor to provide trained men for many industries, few, if any, have modern power house machinery with steam as the prime mover. Diesel is available, but that leaves an aspirant for Our Hero's job out on a limb.

The third premise refers to "surplus" and here we have the crux of the situation. Generally speaking, a surplus of men is not available unless an expanding industry plans ahead for such training. It must also be said that of men who might be available by virtue of experience, few if any could be tempted to leave their present berth. This is so apparent when considered in the light of such reasons as their age, home-ties and prospects of participation in retirement and insurance benefits, that other reasons could be irrelevent. As to the possibility of an understudy being tempted to change pastures, it must be said that by the time he is properly qualified, he will surely be given to understand that an opening will soon be ready for him. Again I suggest that few if any, surplus apprentices are on the pay roll.

Now civil service must occupy a unique place in this discussion for there is only one reason that can properly be used to justify the taking of men from private industry and it is that of public service. But here we must get technical. Can that be used when a city draws men from without its own limits? Anyway, we must get down to cases and recognize the fact that notwithstanding the circumstance of Our Hero having placed his appeal on the nationwide basis, there was no soap. And here is the thing that would have worked for him. He should have accumulated a number of men with certain qualifications and he should have had them organized and ready to take up a course of study; paying particular attention to the various phases and steps in the construction of the plant.

In addition to this and to guarantee the success of the plan, a sufficient number of retired men, qualified by virtue of previous experience to assume responsibility of operation, should have been provided to place the plant in operation and to train the younger men; all of which would be with the understanding that after a designated period the older men would turn over operation of the plant to the younger men.

Such a plan would cost some money, but it is practical and surely the benefits accruing in the knowledge of having stood on his own feet would justify Our Hero should he elect to pursue such a course in future operations.

SELECTED COMMENT

IF IT were possible for readers to review all the papers submitted in this contest they would get, as did the judges, a composite picture of the nation's power plant engineers. As it is the best we can do is to quote briefly, from articles presented, bits of philosophy which indicate the thinking of engineers throughout the country.

"Public utilities seldom hire an engineer," says Charles W. Parks of Baltimore. "They most always hire oilers and boiler scalers. . . . A company of this type has to start to get his personnel completely lined up many months before the plant goes into service. Probably one of the best methods that I know to insure that you will be able to start up your steam turbine generator is to start when the first piece of your tubrine arrives from the factory. Hire a number of engineers in advance and have them on hand to follow the course of erection through to the end." These men should then be instructed by the turbine mechanics and engineers in the art of handling every detail of the equipment.

From E. H. Carlson of Fresno, Calif., we get the opinion that there is a real shortage of skilled workers that cannot be filled from the ranks of the unemployed. This, he says, is particularly true in California where nearly all of the electrical energy is produced by a network of hydro plants located in the mountainous districts and at Boulder Dam. "Civil service examinations and red tape," he asserts, "inevitably involve loss of time, delay, financial sacrifice, possible difficulties with present employers and other inconvenience, and in the end the

aspiring engineer has at best only an expectancy of gaining a better position."

It is the opinion of Lislie Bradley of Bismarck, N. D., that Our Hero should get in touch with several different chief engineers who have charge of plants somewhat similar to his own. In most cases, he thinks, these engineers have at least one man in their plant that they can recommend to fill the position in question.

Just what should a competent, ambitious engineer look for in seeking employment? The answer to this question would give Our Hero some selling ideas to work with, at least so William Sheffer of Wingdale, N. Y., thinks and enumerates the following as points to be considered: "1. The future should hold, not only a chance of advancement, but a possibility of salary increase, disability and life insurance, a reliable and efficient pension system that would insure the employee of a living upon reaching superannuation. 2. Working conditions—These would include a safe plant, and a clean plant. Means to insure cooperation among the plant personnel should be taken. 3. Living conditions—These would include the cost of or decent rent, food and other necessities; school and church facilities, domestic water and sanitary arrangements."

Many of the contestants think that Our Hero should train his top men from the lower ranks which is concisely phrased by C. C. Custer of Logansport, Ind., as follows: "When there is a scarcity of help, it is often necessary for a successful manager to train his own help. It creates a much better feeling in any corporation if all the various employees get the idea that it is possible for them to get promotion as fast as they get experience and can be trusted with the work, and where there are positions to fill it is always better to look around the organization for some one to promote than it is to bring outsiders in over old employees. Employees must be shown that they must perfect themselves in the business and then preferment will come as a matter of course."

The political aspects of the Glendale jobs were mentioned by nearly all writers as an undesirable feature. Typical of these remarks is the following by R. Atland of Staten Island, N. Y.: "I would not want this position for myself because

of the chance of someone else hiring political friends and pushing them into my plant. This practice results in a staff of incompetent and politically protected employees. To no industry is reliability as important as to the power plant, and the human element is the corner stone of reliability. We as engineers can adopt as a motto 'No responsibility without authority'."

As indicated in the opening paragraphs, this problem of hiring top notch engineers touches upon practically every human activity of the engineer. The breadth of the problem is well indicated by statements from Paul F. Dickens of Quanah, Tex., who thinks there is nothing wrong with the Glendale proposition itself, but "It is a known fact that the industrial and utility power plant programs of construction are on the increase throughout the country; and that a resulting demand will be made on the engineering profession for competent engineers to operate these power plants, which may reveal a shortage pretty nearly equal to that of the proverbial hen's teeth. This possibility of a scarcity of engineers throughout the country can be due partly to the fact that in the past 10 yr. jobs have been a little scarce, causing those holding positions to continue to hold them; and the results are that these men are now too old to take new jobs, and the younger generation of would-be engineers are still would-be's.

"Another possibility is due partly to the fact that most companies, realizing the value and importance of a competent engineer, are striving to keep them on the job. They are accomplishing this by paying their men good salaries, offering them life insurance and retirement annuity programs, hospital and medical service, all for a very small fee, and having a personnel relations department that maintains a constant personal contact with every person on the payroll. They promote good feeling between employer and employee through banquets, gab fests, and safety meetings where the individual is made to feel that he is more than just a cogwheel in the plant. The result is loyal and steady men, who are happy and satisfied in their jobs; they are owners of nice homes, nice cars, are outstanding in their communities, their children go to schools and colleges, and therefore, they have no desire to leave their present positions and go to a new position in a new country."

Purging Non-Condensible Gases from Refrigerating Systems

By George Blum

UNLESS pressure is required to lift a liquid refrigerant to evaporators high above the condensers, low discharge pressure is requisite to the safe and efficient operation of refrigerating systems. This is especially essential to maintenance of low power costs and to minimum loss of refrigerant through leaks and oil blowdowns. The chief factors governing the discharge pressure are temperature of condensing water, cleanliness of heat transfer surface, ratio of heat transfer surface to quantity of refrigerant to be condensed, kind of refrigerant used and the presence or absence of non-condensible gases in the condenser or in the space above the liquid in the receiver. It is with this latter problem that this paper deals.

Manual Method

In general, purging of non-condensible gases from refrigerating systems may be accomplished in two ways: Manually, which while effective is usually accompanied by a greater or lesser loss of refrigerant; and by the automatic non-condensible gas purge. Of these purges there are several types on the market, all operating on the same principle, and with a medium loss of refrigerant. Since purging manually is the older of the two methods, it will be considered first.

The first move in purging manually is to close the master liquid stop valve and pump out the low pressure side or sides of the system. A pumpout may seem beside the point. It isn't. For in pumping out the low pressure side of the system, the liquid receiver, and perhaps the lower part of the condenser, will be filled with liquid refrigerant. If the liquid level rises in the condenser, the capacity of that vessel will be reduced. But with the suction pressure falling with the pumpout, the input of gas to the condenser should just about equal the output of liquid condensed with the decreasing capacity. The important point of this procedure is that while condensation of the ammonia gas prevents a partial pressure rise of that constituent in the mixture of gases in the condenser and receiver, the rising level of the liquid compresses the non-condensible gases, and raises their partial pressures and the total pressure per square inch in the system. The water is left flowing over the condenser after the compressors are shut down.

Many engineers urge that purging be done very slowly. Books on refrigeration often give the same advice. But the slowest way is not the proper way to purge. Of course, the purge valve should not be opened so wide that the rapid fall in pressure will cause the liquid lying in the receiver and in the bottom of the condenser to boil violently, or for the refrigerant gas to blow out through the absorbing fluid before the fluid can absorb it. For as the purging proceeds, the pressure exerted upon the liquid ammonia by the mixture of ammonia gas and non-condensible gases diminishes, and evaporation of the liquid begins. The gas freshly formed by evaporation rises and diffuses into the mixture of gases above it.

If purging takes place more slowly than diffusion, some of the freshly evaporated gas will be purged, and the refrigerant loss increased. The golden mean of purging is to purge at the same rate of speed as evaporation without the turbulence of rapid boiling. Here again, is a factor many engineers forget: The pressure drop which may set the liquid to boiling violently will not be the total pressure drop, but only the partial pressure drop caused by the loss of the ammonia gas constituent of the mixture of gases being purged. If the purged valve is opened, say one full turn, and left that way until purging is complete, the total pressure will fall in a steadily decreasing ratio as the pressure differential between the total pressure and the atmospheric pressure decreases. But the partial pressure of the ammonia gas constituent of the mixture will be maintained by evaporation of the liquid.

Regardless of the total pressure variation, the partial pressure of the ammonia gas will remain constant at the pressure corresponding to the saturated ammonia vapor pressure at the temperature of the water circulating through or over the condenser. No ammonia gas will rise to take the place of the non-condensible gases being purged, but only to take the place of the ammonia gas being purged with the non-condensible gases. Of course, some diffusion of the freshly evolved ammonia gas with the mixture of gases above it will take place, even in a very short while. But the longer the purging time, the more diffusion will take place, and the more ammonia gas must be purged to get at the non-condensible gases. This is why purging should take place as rapidly as possible without allowing the partial pressure drop of the ammonia gas constituent of the mixture to set up enough turbulence of ebullition to agitate the constantly rising diffusion line. And if purging is rapid, the diffusion line will soon have risen above the agitation of ebullition.

Automatic Purging

The so-called automatic non-condensible gas purge works differently from hand purging. Unless there is a large system, or a large group of systems, it is the better policy to operate an automatic purge only when needed than to leave it in constant operation. In the use of this piece of equipment, the method will depend on whether the purge connects into the condenser or into the liquid receiver. Assuming that it connects into the receiver, from the upper part of which the mixture of gases is drawn and into the lower part of which the condensed refrigerant returns, purging should be done with all compressors in normal operation. The only change necessary is to close the stop valve on the liquid line from the condensers. This will hold the condensing liquid in the condenser, at least until the liquid level rises to the point where the equalizer line taps in. The rising liquid level in the condenser and the fresh gas coming in from the compressors will drive the non-condensible gases through the equalizer line into the upper part of the liquid receiver. The level of the liquid in the receiver will fall, the volume of the gas space increases and is filled with the non-condensible gas mixture being driven from the condenser. The simple act of closing the liquid stop valve on the line from the condenser to the receiver brings the mixture of non-condensible gases directly up to the intake of the purge.

Notes On Belting

By W. F. Schaphorst

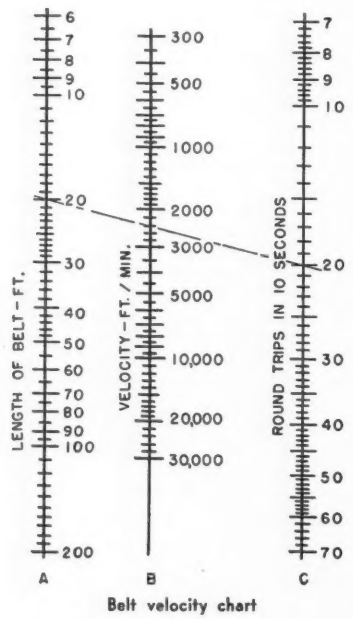
THERE are a few important pointers concerning quarter-turn drives that are seldom mentioned. To prevent crooked belts because of the side pull that is inevitable in most quarter-turn drives, one edge of the belt is stretched more than the other and in time the belt is likely to become crooked. It then begins to work over to one side and in time will run off. Also the joint is likely to open on one side.

Where the distance between pulleys is sufficiently great this can be remedied by giving the belt a half twist. That is, instead of cementing or joining the belt in the usual way, turn one of the ends through 180 deg. Then join the two ends together. This half twist causes the belt to change sides with every other revolution of the belt and the tension on both edges is thus equalized. A good rule to follow in laying out quarter-turn drives is this: The distance between shaft centers should be at least five times the diameter of the larger pulley. Thus, if the larger pulley is 20 in. in diameter, the distance between the shaft center should be at least 100 in.

A properly designed quarter-turn drive will transmit almost as much power as a normal open drive under the same conditions. But it is wise nevertheless to use a belt from 5 to 10 per cent wider in order to assure a sufficiently high factor of safety.

Wherever it is possible the pulley on the vertical shaft should be the driver, that is, provided one of the shafts must be vertical. This is so because then the tight side of the belt runs onto the pulley the plane of which is horizontal. Obviously, if there is any slackness in the belt, trouble will be experienced, especially if the pulley on the horizontal shaft is the driver.

In the event that the pulley on the vertical shaft is the driven pulley, with the belt persisting in running off, tightening the belt is one remedy. If it still persists in running off it may be necessary to increase the crown of the pulley on the vertical shaft.



Belt velocity chart

Measuring Velocity

Make a mark that will be visible on the outside of the belt. Then estimate the length of the belt in feet. If the belt is 20 ft. long you now know that every time the mark makes a "round trip" the belt travels 20 ft. Count the number of round trips in 10 seconds. Then apply the accompanying chart. For example, a belt is 20 ft. long and makes 20 round trips in 10 seconds, connect the 20 in column A with the 20 in column C, and the intersection of the connecting straight line with column B gives the answer as 2400 ft. per minute.

Cleaning Belts

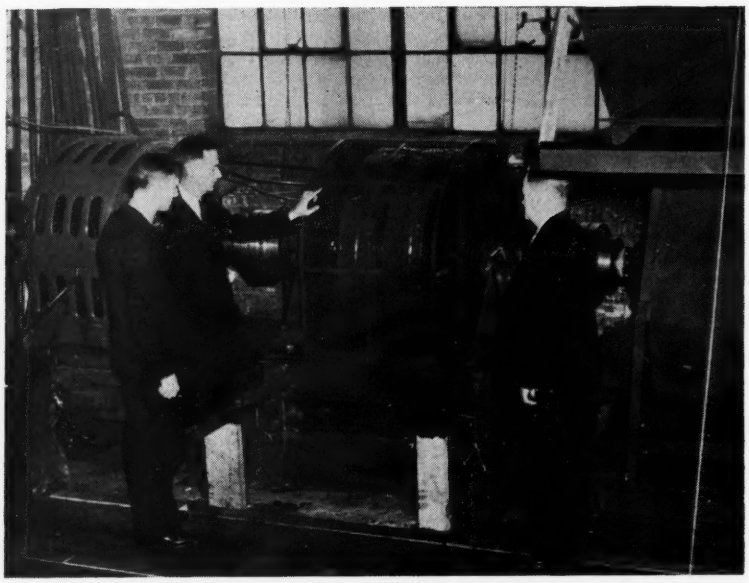
The utmost caution must always be exercised in the use of steam for cleaning belting. Steam is an excellent cleanser for many purposes, that is true, but it must be remembered that many kinds of belting cannot withstand the high temperatures that go with steam. The temperature of steam at atmospheric pressure is 212 deg. F. The higher the steam pressure the higher the corresponding temperature. Most rubber belting cannot withstand temperatures of 212 deg. F.

One prominent rubber belt manufacturer states that his belting is not affected by heat up to a temperature of 200 deg. F. He states that where higher temperatures are to be encountered he should first be consulted. That is good advice regardless of the kind of belt. Even where steel chains are used one must be careful in high temperatures or lubrication difficulties will be experienced. Of course steel chains can be cleaned safely with steam.

Balata belting is more sensitive to high temperatures than rubber. Its temperature should be kept down to less than 110 deg. F. At 125 deg. balata gum can be moulded.

According to one well known authority on the subject, oak tanned leather belting should not be subjected to a temperature higher than 115 deg. F., which means, of course, that oak belting should never be cleaned with steam.

Nor should impregnated cotton belting be cleaned with steam because the steam will very likely wash out the impregnating compound. Without the compound cotton belting does not give satisfactory results. Stitched canvas belting should not be used in temperatures higher than 140 deg. F.



Magnetic Variable-Speed Drive

Tests recently conducted on the magnetic variable speed drive shown in the accompanying photograph demonstrated that this equipment has the fast speed response demanded of many power plant auxiliaries. Inspecting the equipment are, left to right, M. E. Fitze, power plant test engineer of the Wisconsin Electric Power Co., R. N. Early, design engineer of the Electric Machinery Mfg. Co. and O. M. Ward, superintendent of electrical operation of the Wisconsin Electric Power Co. The lists showed that the forced draft fan connected to the magnetic variable-device and driven through it by a synchronous motor developed an acceleration in speed from 10 to 97 per cent in 4 sec., and from 20 to 80 per cent in 2.2 sec. The motor has a capacity of 300 hp. and a speed of 900 r.p.m. Essentially the magnetic variable-speed drive consists of a flux ring connected to the driving motor, and within this ring, a magnet, which is connected to the fan. The magnet is excited from a small source of direct current. By controlling the current to the magnet, the speed of the magnet with relation to the ring, hence the speed of the fan can be adjusted at will.

Letters and Comments

It's Your Furnace

IT APPEARS to me that the first part of the article "It's Your Furnace," by G. Campbell Kohlar, on page 45 of the March issue is not coordinated with the latter part. Mr. Kohler states in the fourth paragraph of this article that slag-tapping has made pulverized fuel economically feasible, and then goes on to state:

"True, it is possible to build a steam generator with a dry furnace, and such units have been built. But ordinarily, the cost of such unit and the expensive fuels to which they are limited prohibit their general use."

This does not seemingly agree, as I interpret it, with the following statement to be found in the latter part of the same article:

"Nearly all of the units of the size which we have been considering have dry ash removal systems, therefore slag-tap floors will not be discussed."

I would be interested in advice as to how to reconcile two such divergent angles of thought.

PETER H. TUTTLE,
Vice-President
Cortright Coal Co.
New York City.

* * *

The first portion of the article "It's Your Furnace" briefly traced the history and development of the furnace. At this point the statement was made that slag-tapping was responsible for making the burning of pulverized coal economically possible because the initial cost and the expensive fuels to which dry bottom furnaces are limited prohibit their general use.

This applies specifically to high-pressure, high-temperature steam generators, and it was my belief that the context had made this connection clear. The article then went on to discuss some of the problems which might arise in the design of a furnace, and because of space limitations this discussion was confined to the smaller types of boilers that are usually found in industrial plants. Here I made the remark that nearly all boilers of this type are equipped with dry ash removal systems. If it is kept in mind that each of these statements applies to an entirely different type of unit, I believe that the two statements are consistent.

In order to operate a dry bottom furnace successfully, the liberation in the furnace must be kept within about 35,000 B.t.u. per cu. ft., and it is desirable to burn only those coals which have an ash fusing temperature above 2300 deg. F. In boilers of capacities up to, say, 100,000 lb. per hr., it is economically possible to build a furnace large enough, and with sufficient water-cooled walls, to successfully burn coals with ash fusing temperatures as low as 1900 deg. F. without slag tapping. But even this is no simple matter, for some slag is inevitable and mechanical aids to cleaning, such as sootblowers and deslaggers, must be resorted to.

There are in operation today several large boilers with capacities in the neighborhood of 500,000 lb. per hr., which have upwards of 75,000 B.t.u. per cu. ft. per hr. released in the primary furnace. If it were not for slag tapping, these furnaces would have to be twice, or perhaps three times as large, and even then it is extremely doubtful whether they would be able to handle the comparatively low grade fuels which they now do.

A slag-tap furnace, however, is expensive and few industrial plant engineers have had any experience with them. This, together with the fact that there is no real need for slag-tapping on smaller boilers, has confined the use of this type of floor to the utilities and larger industrial plants. Some attempts have been made to apply slag-tapping to boilers of moderate size, and perhaps the time is not far off when it will be as common as is pulverized coal.

G. CAMPBELL KOHLAR

We're Sorry—Big Betsy's 60 by 66

WE ARE SORRY but one of the men who helped erect Big Betsy, the rolling mill engine installed in Youngstown and mentioned on page 77 of the April issue, draws our attention to the fact that the correct cylinder dimensions are 60 by 66 in., the rated speed is 95 r.p.m. (piston speed 1045 f.p.m.) and that he has charts showing 17,000 i.hp. at that speed in four revolutions from friction load. Although operated at 165 lb. pressure, the engine was designed for a higher pressure in a future expansion program, somewhat around 225 lb. and he says she would develop 25,000 i.hp. "if she got good and mad." Steel has been rolled for several hours at 101 r.p.m. with steel going through at 750 f.p.m. We are informed that she saved somewhat over $3000 a day over the same tonnage with four old engines and that she paid for herself in less than four months.

Editor.

PRACTICAL HINTS AND KINKS

Rust Protection

PROTECTION of steel products from rust and corrosion during storage or shipment can be prevented by a film of oil. These so-called slushing oils are available in a wide variety to meet different requirements. In a comprehensive investigation of this subject and covering 11 types of rust, the Texas Co. determined that the necessary requirements of ease of application, maximum protection and ease of removal can usually be met by oils of low viscosity ranging from 35 to 250 S.S.U. at 100 deg. F.

Such oils fall into two broad classifications: straight mineral oils; and special rustproofing oils with a petroleum base. Both paraffin or naphthene base oils can be used with equal results. Straight mineral oils are cheapest and are widely used in the steel industry. Viscosities range from 85 to 250 S.S.U. at 100 deg. F. with an average of about 100. Higher values than 250 involve danger from slips or skids of stacked sheets.

Unwrapped steel exposed to atmospheric variations and condensation are not adequately protected by straight mineral oils and should have special slushing oils with greater rust resisting qualities. These usually consist of a petroleum base with the addition of materials such as: fatty compounds, soaps, metallic compounds, mineral oil derivatives, etc. Some are more effective than others and some have a tendency to develop corrosion themselves after long periods of storage.

Thus lanolin, lard and other fatty oils adhere well to the steel and form emulsions with water but after long periods tend to oxidize and form fatty acids. By special treatment certain of these can be made very resistant to oxidation, however.

Removal of these slushing oils is often of importance. All types can be removed sufficiently for most purposes by rubbing with a kerosene soaked rag. Hot alkaline solutions will remove all oils, although the greasy type offers a little more difficulty. An organic solvent such as tri-chlor-ethylene will remove straight mineral and fatty types easily but the water soluble soap types offer more difficulty because they are not completely soluble in the solvent.

Rubber Hose

RUBBER HOSE is vulcanized at approximately 265 deg. F. and should not be subjected to steam pressures of much above 125 lb. ga., if good life and service are to be expected. Due to the con-

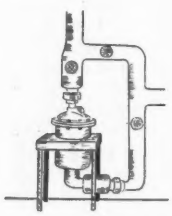
struction kinks should be avoided and the hose permitted to turn and take its natural shape. Heavy objects should not be allowed to run over or rest on the hose and it should not be bent at too sharp a radius unless it is especially designed for this purpose. Heavy types of hose when suspended should have adequate support to distribute the strain. Suction hose should not be used for discharge service and vice versa. Neither should water hose be used for steam. When stored the hose should be kept in a cool, dark place away from direct sunlight.

When attaching fittings the shank of the fitting should be sharpened to fit the hose. If it is too large or has rough edges, rubber lining will be ruptured before the hose is placed in service. When applying, the end of the coupling should be put in a vice and the shank covered with rubber cement, although shellac or liquid soap can be used for this purpose if cement is not available. The hose should then be slipped gently over the shank and secured with a clamp. Double bolt clamps may be placed over the hose after it is inserted in the coupling but single bolt clamps should be slid over the hose before it is placed on the shank.

Pipe Inspection

AFTER NEW STEAM PIPING is in place on a job and before the insulation is applied, it should be tested for leaks. Common practice is to apply hydrostatic pressures two and one-half times as great as the steam working pressure. If a job stays tight at this pressure for 4 or 5 hr., it is deemed satisfactory and should remain tight under the normal steam pressure. Careful inspection should be made to detect poor materials, but if shop inspection has been rigid, none of the parts should have to be replaced after erection.

Some designers and erectors purposely plan to give all steam piping an original strain by pulling up bends and long offsets, knowing that after the steam has been turned on, these strains disappear as the pipes expand. It is also true that, even if strains are set up due to expansion in such lines, after some time has elapsed, the systems adjust themselves and all stresses are equalized. This is particularly true when the designs are such that no solid anchorages are installed.



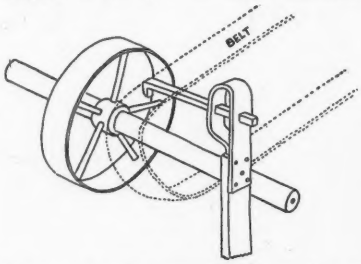
Pipe Support

SUPPORTING branch pipes in out of the way corners is often difficult and requires a great deal of ingenuity. The sketch shows how a trap and piping is supported in a location of that kind in the municipal power plant at Worthington, Minn.

Improved Belt Stick

By Chas. H. Willey

CONSISTING of a long hard wood stick and a round pin secured to its end, the belt stick is a common tool. The sketch shows how it can be improved by using the hardwood stick with a formed support of ¼ by 1 in. steel. Through



this runs a square bar of ½ in. steel, one end of which is bent over at a right angle. In operation the usual procedure of looping the belt over the pin is followed. The belt is forced on as the stick is pushed towards the pulley while the bent end of the pin contacts and is stopped by the rim of the pulley.

Hot Water Helps Softener

By M. A. Rae

FOR SOME TIME we have been having trouble with dead lime caking on the bottom of the mixing tank, after making up a charge to soften boiler feedwater. Practically everything had been tried with no apparent success; pitch on agitator blades had been changed; and speed of blades had been increased, but still the dead lime caked on the bottom of the tank.

It was noticed that caking of lime on the bottom was particularly bad during cold weather, and then when one of the engineers remembered that a plant in which he had formerly been employed had used hot water in mixing the chemicals instead of the cold water. It was decided to try this as a last resort since every other means had failed. Shortly after the installation of the hot water makeup, the caked lime disappeared from the bottom of the tank and since then we have had no trouble.

In plants where they are having this same trouble, and it is impossible to hook up a hot water connection, it may be possible to put in a steam lead to the bottom of the tank, this would no doubt heat up the mixed chemicals but would also aid in agitation for better mixing.

Temporary Button Fastener

By Frank Bentley

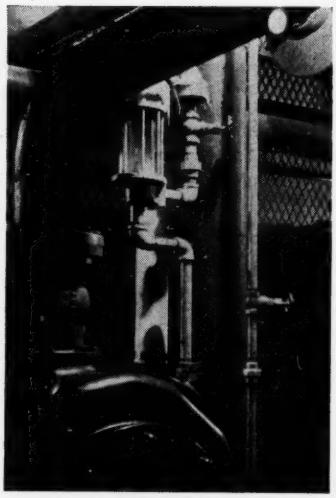
DURING the erection of some plant machinery a signal buzzer was found to be a handy thing in trying out many of the parts as they were installed on a floor below. A button that could be kept out of the way, handy, and fastened to any surface was necessary. One was made as shown above. A common auto signal or horn button was fastened to two ordinary vacuum or sticker cups with two battery nuts. They held the button to any metal or smooth surface handily and securely, though removable instantly when necessary to take to another part of the job. The three pieces necessary were quite inexpensively obtained at an auto accessory shop.

Combination of ordinary auto gadgets made handy removable button for temporary signal buzzer.

Flow Indicator

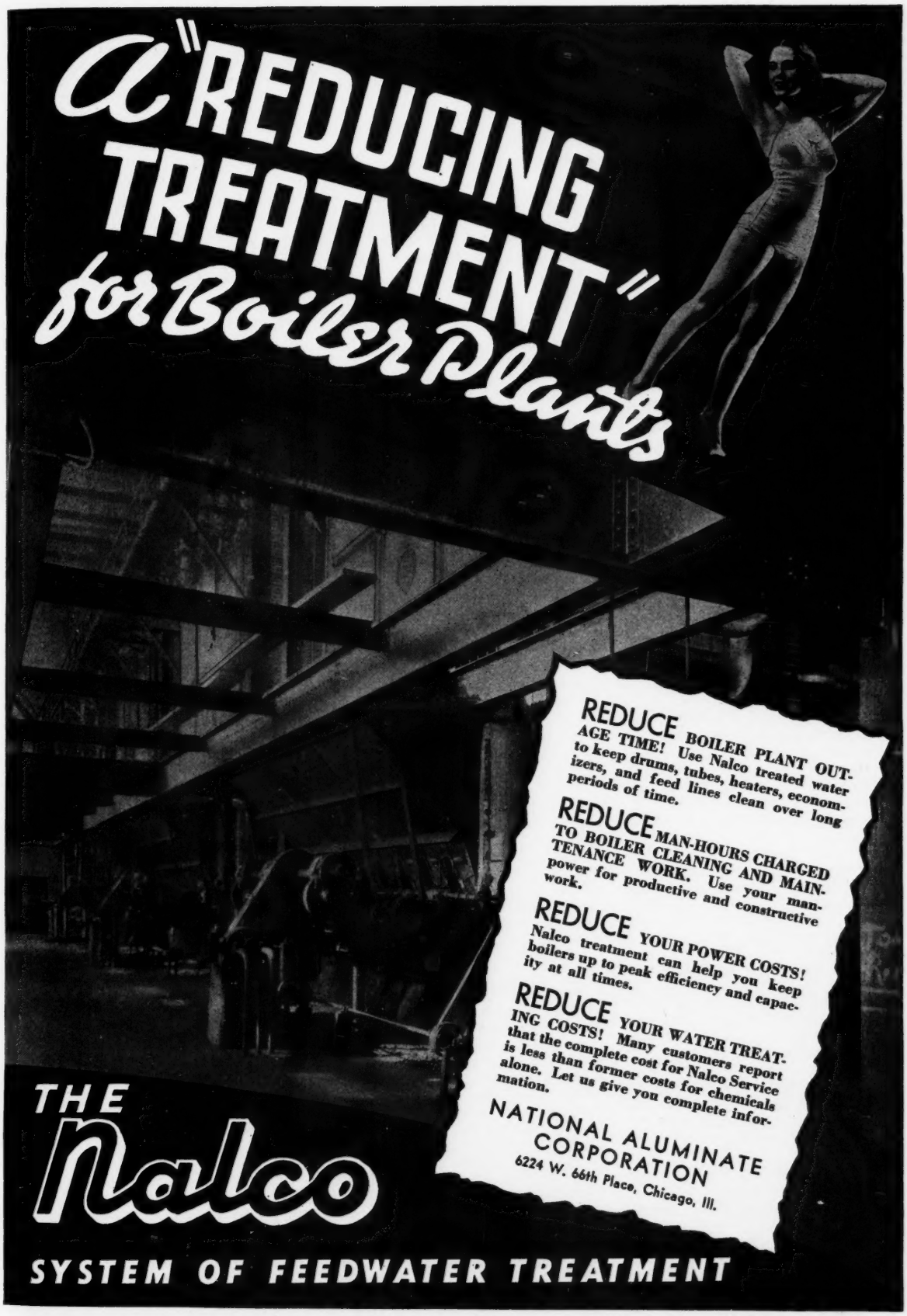
By James P. Marshall

USUALLY compressors are installed so that the cooling water, after leaving the cylinder, runs through an open iron funnel, giving visible proof when the water is flowing. When the machine is installed below drain level, however, or when it is desirable to boost the waste water to some point above the machine, then the water must run in a closed system and it is then difficult to determine whether or not the water is flowing properly.



Spinner indicates cooling water flow

A sight-flow indicator, equipped with a spinner, may be taken from an old gasoline pump and installed in the line as shown in the illustration thereby providing continuous visible proof of flow conditions within the piping system, and thus preventing possible costly repairs which would most certainly be necessary if the compressor should run for any length of time without a proper supply of cooling water.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Questions And Answers

Keeping Posted

As THE WRITER now occupies, and always has occupied, a position of exceedingly modest nature, it is with some temerity that he undertakes to comment on such a serious subject as "Employee Relationship" as brought up by the question "How to Keep Posted" in the January issue, page 94. Due to the vagaries of human nature, one of the most difficult undertakings for an executive to pursue is the betterment of his relationship with his employees as individuals.

Because of his acquaintanceship with the average worker through shop intimacy, and with executives through social contacts, the writer is of the very definite opinion that the average executive is more intellectual, with more education (not necessarily formal), and knowledge than the average worker, because of these, and other reasons, there is often considerable jealousy, envy and even hatred on the part of the worker. Sometimes, though not always, there is a tendency to despise or ignore the underling on the part of the executive. To be perfectly fair, we admit that "the Boss", because of inherent superior characteristics, is prone to be more tolerant than the worker. Thus, the preamble.

Fairness is the beginning of mutual understanding. Do not reward, or punish, without ample cause. Keep relatives and friends in positions commensurate with their ability. Do not push them. Require more from them than you do from the other employees because they should give more.

Don't make a fetish of seniority. If a promotion hinges on seniority, OK. Otherwise, NO.

Be tolerant of the employees ideas, when they differ from your own. Remember, that it is none of your business, in this country at least, how your men vote, what they worship, or what breed of dog they prefer.

Stand firmly between your men, and those over you. If you do this, you will never know what it is to have a man "go over your head".

Do not think that age has a monopoly on intelligence, or youth a corner on ignorance. Listen, to everyone. We can all learn.

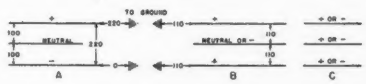
If you maintain schools or classes for the men, promote those men who attend the classes, for that is encouraging them.

Remember, that among other things, an executive must be a psychologist. As a psychologist can tell the "Manner of the man", he does not employ stools to do so.

Maintain discipline. "Mr. Jones" is a more efficient oiler than "Old Bill". Besides, many men resent, and look askance at what they consider undue familiarity. Some men maintain a dignity far beyond their station. Let them have their fun, as it is a defence mechanism. W. S.

Comment on Problem 9

I HOPE Oscar has not tried to hook up his alarm system according to Mr. Hensgen's diagram in Problem 9 if he has a. c., if, however, he has d. c. and hooks his lights on the positive side they will work all right unless he has a two-wire generator with one wire grounded then his lamps will burn out because they would be on the 220-v. circuit.



Diagrams for electric circuits

Diagram A represents a two-wire 220-v. d. c. generator with one side grounded; B, a three-wire d. c. generator with a 110 v. from either + wire to ground; C, an a. c. system. In the a. c. system a resistance would have to be placed in the line to prevent the fuse on the wire that was connected to the tank without lamps from blowing.

Chicago, Ill. HAROLD D. BROWN

Hot Water Pipes Corrode

WITHIN the last couple of years, we have been having trouble with our hot water pipes. Every two or three weeks a leak will develop which invariably is caused by a small pin-hole having been eaten through the pipe by the water. When we have examined the interior of the pipe, we find that it is almost completely plugged up with thick bubbles of iron oxide. We analyzed this deposit and found that it contained iron oxide with traces of calcium carbonate and calcium sulphate. The water in the hot water lines is first passed through a zeolite water softener before being heated, as it is high in calcium and magnesium hardness. The cold water lines do not have this trouble, although the same water is passed through them, except that the cold water is not softened.

Our problem is to remove this scale without shutting down the entire system, and at the same time keep the water pure enough for drinking purposes, and we could not tolerate an excessive amount of rust in the water. We recognize the fact that the only real cure is to replace the iron pipe with copper pipe, which we are doing wherever possible, but since there is a large amount of inaccessible piping, we would like to save this pipe if possible. Perhaps some other engineer has had the same trouble, and can tell us what to do.

Carlsbad, Calif. K. A.

Internal Boiler Water Treatment

ON THE problem of the evaporator, discussed in these pages for several issues, all the correspondents seem to take it for granted that a boiler must have distilled water that they never heard of such a thing as a boiler using 100 per cent raw water. Of course since the plant has the evaporators most likely the best solution is to use them but the question of feeding the boilers with raw water should not be completely ignored. It may be cheaper to treat the water than evaporate it. There is a certain amount of expense connected with the operation of the evaporators. We are not far off if we assume 10 per cent heat loss, due to radiation, leaks, blow downs, lack of heat balance, etc. One of your correspondents has estimated the annual fuel bill of this plant over $6000. The 10 per cent loss of this will be $600 and this is several times what it will cost to treat the water internally. For the benefit of those who may shudder at the thought of using raw water for 100 per cent of the feed I will say that I now work in a power plant using 100 per cent raw feed with internal treatment costing about $1 per 300,000 lb. of water treated and without any operating difficulties.

The fact that Our Hero has solved the problem by the use of the evaporators does not mean that the last chapter of the story has been written. Shut down the evaporators and treat the water internally for one year and then compare notes.

There will be no cost of investment to treat the water internally. The chemical company usually furnishes the container to feed the compound and the usual place to introduce the compound in the system as at the open heater or at the suction of the feed pump if an open heater is not available.

Oak Park, Ill. N. T. PEF

* * *

Litmus paper, which can be purchased at any drug store or chemical supply house, is a convenient method of indicating the alkaline or acid condition of a solution and it is widely used in refrigerating plants for testing ammonia leaks into brine. An alkaline solution will turn red litmus paper blue, while an acid solution will turn blue litmus paper red.

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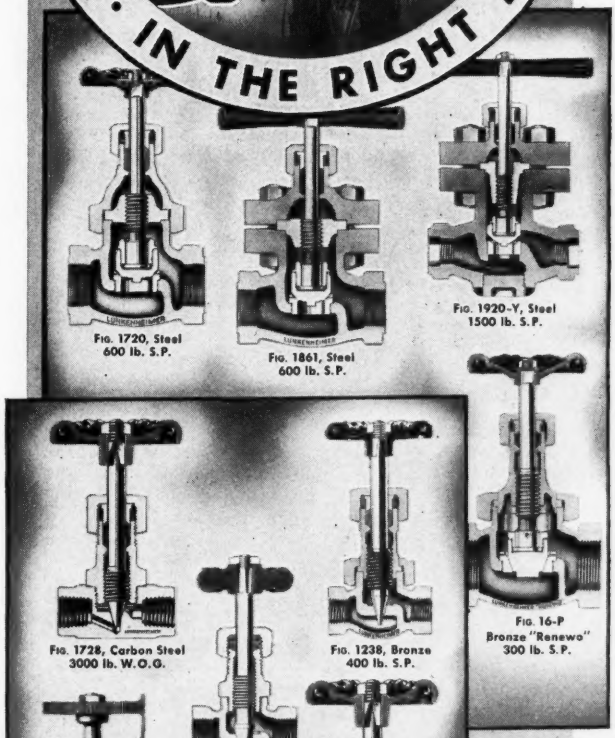

Behind the super-sensitive instruments which guide today's engineer in his constant search for ever-greater operating efficiency and lower operating costs are mazes of pipe lines through which the flow of liquids and gases must be accurately controlled at all times. For such service, only valves of the finest design, materials, and workmanship are worthy of their hire . . . so, it is natural that Lunkenheimer should pay special attention to the production of throttling and needle point valves for every instrument line, drain, and by-pass requirement.

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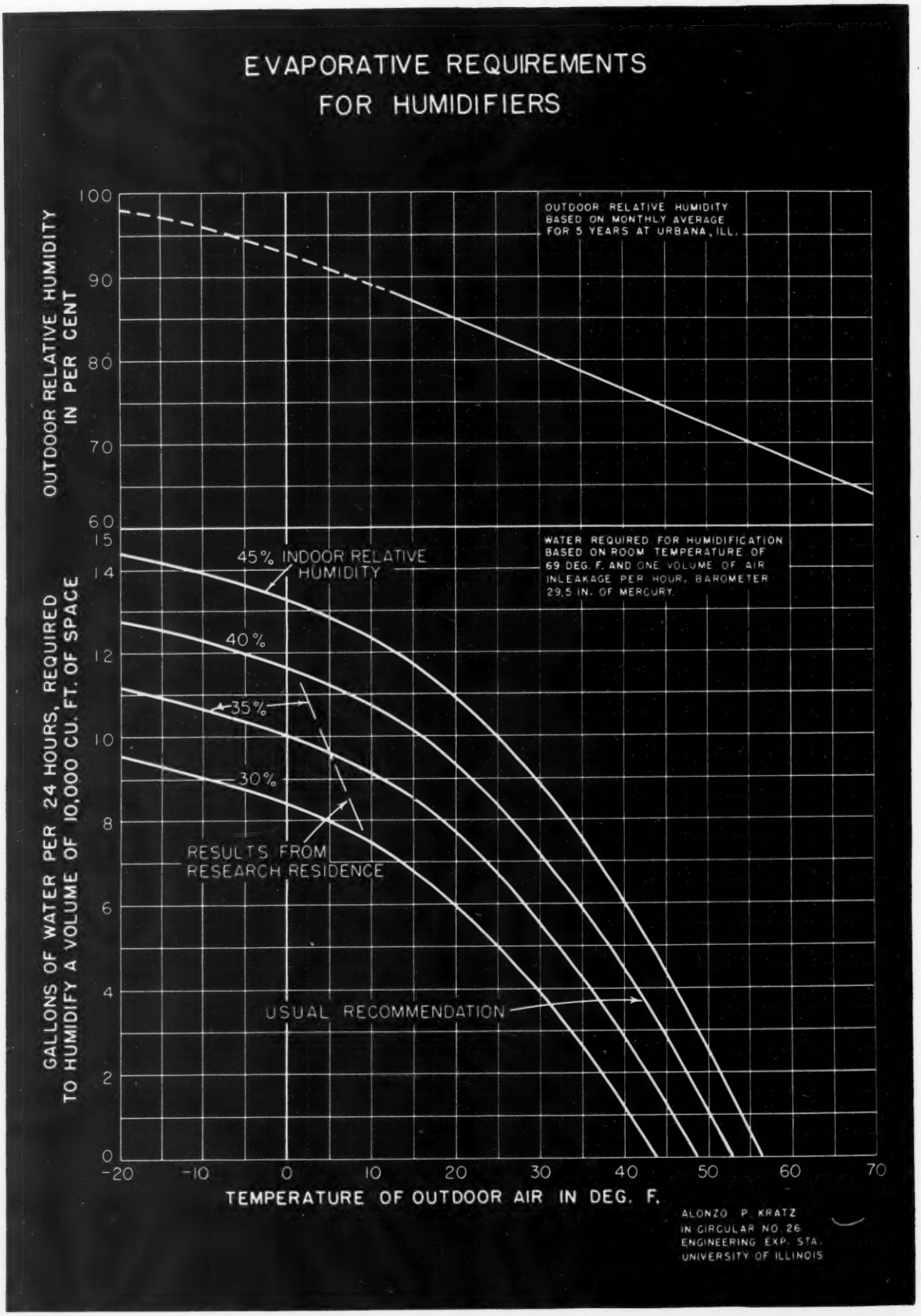
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80
70
60
15
14
12
10
8
6
4
2
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-10
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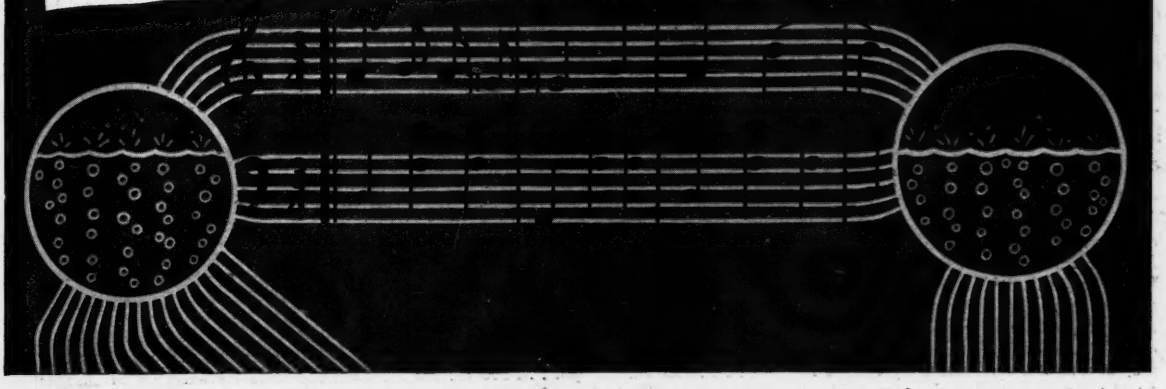

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'Round About
with the Engineering Editor

SPEEDING CROSSCOUNTRY on paved roads at 60 m.p.h. one thing seems unreal . . . the indomitable spirit which drove the early pioneers across hundreds of miles of hostile plains, rugged mountains and lonely arid desert . . . Weeks of uncertainty, each mile a fight, a month's work for the distance which can now be covered comfortably in a day . . . It is real, however, for the deeply rutted tracks are still visible in many sections . . . Nowhere more plain and accessible than over Emigrant's Pass in Lassen National Park . . .

The track can be followed for miles through the manzanita . . . Some places badly overgrown, occasionally a turnout where a fallen tree was easier circled than cut away . . . In times gone by, I've lived and worked in many sections of the West, covered much of it on horseback, buckboard and auto . . . in the days when a dirt road didn't cause heart failure . . . Hours through a dust cloud in low or second gear across a rutted valley . . . nothing has ever equalled the appeal of the old Oregon, Mormon, Overland, Sante Fe and a score of lesser known trails . . . A people with such ancestors could not fail to make a nation.

It is surprising, however, how inaccurate road map mileage is . . . The triangle—Chicago-Los Angeles-San Francisco—totals 5217 mi. on the map but 9281 on the speedometer . . . Translated into gas and oil it was 589 gal. and 60 qt. . . . Averages . . . gas 19.8 ct. per gal. . . . 15.7 mi. per gal. . . . 230 mi. per qt. (with allowance for waste on oil changes) . . . In normal driving the corresponding figures are 17.7 and 335 . . . Highest mileage between tank refills 23.2 mi. per gal. and lowest 8.5 mi. per gal. . . . Principal highways used, U.S. 66, 85, 280, 64, 89, 91, Cal. 1, U.S. 50, 40, 30, 187, 16 and 20 . . . Longest single jumps, Custer, S. D., to Chicago, 1063 mi.; second longest, Truckee, Cal., via Tahoe Ely, S. L. C. to Provo, Utah, 651 mi. . . . Cabins for four from $1.75 to $7.00; average about $3.50 with price no indication of quality.

Best marked highways, Missouri . . . Most annoying, Western Oklahoma and Texas because of the 15 and 20 mi. speed limits through the small towns . . . Worst to drive at night, California because they never heard of dimmers and road edges are indistinct . . . Best to drive, Nevada, new roads, wide turns, little traffic and the sky's the limit . . . Most dangerous, Yellowstone, where a car may stop anywhere in the middle of the road, all four doors open and kids from 3 to 90 erupt all over the road to look at a bear . . . Rangers' favorite joke in Yellowstone: "Don't feed the bears—last year a boy was bitten between the Thumb and Old Faithful" . . .

Friendliest and most enjoyable state, Wyoming . . . Most unique spot, Devil's Tower, Wyo., a 1200 ft. chimney of stone . . . Climbed by the way, a few years ago by AWK's Alpine Clubber, Fritz Wiessner . . . If you don't know who he is look up the S.E. Post Mar. 16, p. 9, Lost Behind the Ranges . . . Most spectacular, Zion . . . Hardest to believe, floating like a cork on Great Salt Lake . . . Hottest, Boulder City, not even a swim in Lake Mead helped much . . . Most picturesque, the cedars and rugged coast at Point Lobos, Cal. . . . Most delightful, the Needles section of the Black Hills.

Biggest surprise, Los Angeles after 20 yr. . . . What were then wheat fields, salt marshes and bare mountains are now built solid . . . Canyons we camped in as boys and packed grub in on our backs, are now filled with palatial estates and concrete roads . . . Biggest conglomeration, University of California campus with 14 kinds of architecture piled on top of one another . . . Fortunately the trees are large and thick enough to hide most of it . . . Painting North Hall steps (long since torn down) for the freshmen to scrub off was a fine old tradition . . . George Reed and I daubed on the paint the last time just before the World War . . . George is now engineer at Larsen National Park and took us skiing there on July 3 . . . Spent July 4 at Reno . . . Las Vegas, Nev., may be the widest open town in the country but Reno does pretty well with its prewar standards.

Power Plants? Well, they have loads of them in the West and some mighty fine ones you'll be reading about soon . . . I had to stay out of the Northwest—Mountain Goat Andy Bill Kramer just finished a two weeks' conditioning jaunt with the Canadian Alpine Club . . . With his ice axe, crampons, pitons, rope, etc., he's now covering Washington and Oregon like a fine tooth comb . . . From the razon clams on the beach at Seaside to the foam of Mt. Rainier, he will leave no stone unturned . . . With Andy, every stone turned is a power plant and every power plant a story . . .

Richard H. Morris

Never before has light been used as effectively as at the San Francisco World's Fair where Treasure Island is indeed a gem set in the Bay . . . The night view from the ferry or Bay Bridge is like a glimpse of Fairyland . . . Incidentally, the island will soon lose its glamor but not its romance for it is to be the permanent American seabase of the Trans-Pacific Clippers . . . On the Island each corner brings a scene more beautiful than the last, any one of which excels New York's one and only—from the fountain looking toward the Trylon and Perisphere . . . In the daytime, it lacks New York's size and brilliant contrasting colors but the profusion of flowers, the incomparable landscaping and harmonizing architecture leaves a strong doubt as to whether day or night is more enjoyable.

* * *

Best fishing, Wind River near Du Bois, Wyo. . . . to be exact 50 yd. from the corner of Frank Mockler's UV Ranch house . . . first cast two trout, total 3½ lb. (Honesty makes me admit Frank did this, I needed four casts for the first fish) . . . Lazyman's fishing with two flies . . . If you have to fish more than 100 yr. downstream to catch a mess for breakfast, they just aren't biting . . . Seems it isn't cricket to coax them so you take the six or eight you have and piece out with bacon and eggs . . . Wyoming appetites are husky and the mouths numerous.

* * *

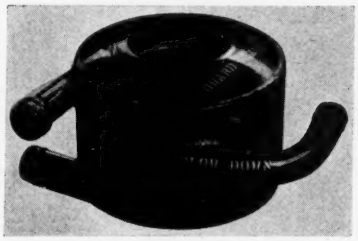
Most discourteous drivers, Los Angeles . . . Most annoying custom. California's border inspection . . . It takes a lot of love of California to put up with some of her ways . . . If I hadn't been brought up and gone to school there and been on the way home with a native daughter expatriate, we would have seen less of California and more of Arizona, (for a second native daughter) New Mexico, Utah, Nevada and Idaho.

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

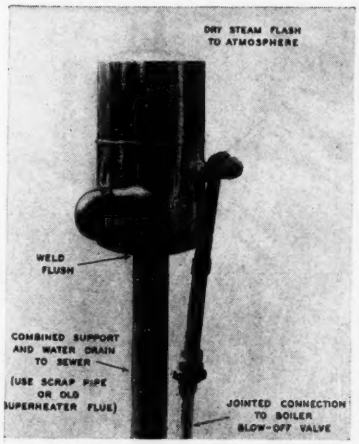
Blowoff Muffler*

FOLLOWING MANY YEARS of successful application of its continuous blow-off separator and muffler, a patented device for locomotive boilers, the Wilson Engineering Corp., Chicago, Ill., applied the same principle of operation to a stationary design. The first stationary application was made in 1934 and the ensuing development work has resulted in minor modifications to meet the varied needs of stationary service.



While the functions and operating principles of the locomotive and stationary designs are identical, the physical appearance differs considerably to better adapt each for its specific application. In the absence of vertical clearance limitations, the height of the stationary type muffler has been doubled, a difference which is apparent in the illustrations. Again the objection to the discharge of vent steam inside a building, or close to the ground, has made it advisable to add to the stationary design a bottom support, which also acts as a drain.

Arrangement and construction of the stationary design is shown by the illustration. This is applicable to all types of plants for any number, size or type of boiler to: muffle the discharge; completely separate the water and flash steam; discharge the steam to atmosphere silently; and drain the water by gravity to the sewer or to a tank under atmospheric pressure and temperature.

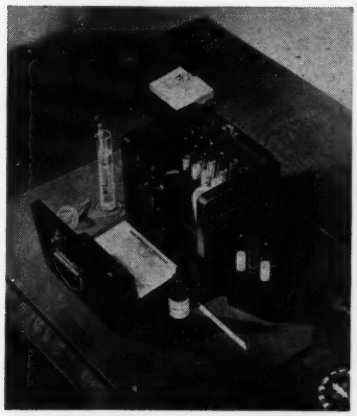

DRY STEAM FLASH TO ATMOSPHERE
WELD FLUSH
COMBINED SUPPORT AND WATER DRAIN TO SEWER
(USE SCRAP PIPE OR OLD SUPERHEATER FLUE)
JOINTED CONNECTION TO BOILER BLOW-OFF VALVE

The self contained support makes it possible to install the muffler on or above the roof at any convenient location. If desired, an auxiliary exhaust connection can be added to the muffler, making a simple and effective exhaust head, for venting waste steam, silently and with the water separated, to the atmosphere. An auxiliary exhaust of this kind is shown on the upper left hand corner of the locomotive muffler. It may be added to, or omitted from either type as desired.

*Editor's Note: This is printed as a correction to a statement made on page 100 of the July issue under the same title and referring to a centrifugal flow-down device as "a new type muffler."

Brine Testing Set

THE YORK ICE MACHINERY CORP., York, Pa., announces the development of an improved brine testing set with: sharper, more permanent color standards; small convenient comparator block; provision for specific gravity determinations; addition of phenolphthalein for quick checks and to determine if samples, out of the pH range of the set, are acid or alkaline; more attractive and convenient carrying case.

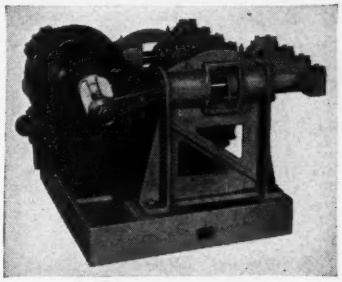


The set utilizes the colorimetric method with universal indicator. There are eleven color standards covering a range of 5 to 10 pH in ½ pH increments. Arrangement is provided for compensating colors in testing colored liquids such as dichromate treated brine. Besides the eleven color standards the bottle of indicator, there is a bottle of phenolphthalein, three test tubes, a minus 30 to plus 120 deg. F. thermometer, 1 by 6 in. glass cylinder and a hydrometer with a specific gravity range of 1.05 to 1.25. No technical training is necessary for the use of the set, and any person who can match colors can make accurate pH determinations.

All parts of the set are securely held in place in an attractive wood carrying case with a mahogany finish and dull nickel hardware. The complete set sells for $20.00 f.o.b. York, Pa.

Proportioning Pump

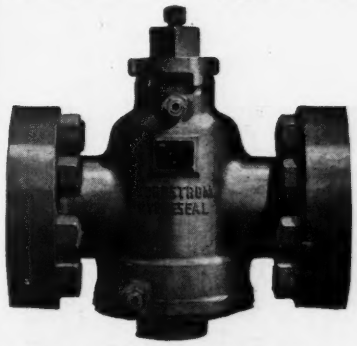
A NEW high pressure, high capacity, duplex proportioning pump announced by Milton Roy Pumps, 3160 Kensington Ave., Philadelphia, Pa. has a capacity of 1200 gal. per hr. Typical construction of these pumps is shown in the accompanying illustration. This particular unit has a



capacity of 480 gal. per hr. against a pressure of 400 lb. It is used to pump an acid solution of phosphate directly into the drums of operating boilers. Pistons and all other metal parts coming into contact with the solution are of special corrosion-resistant stainless steel.

Lubricated Plug Valve

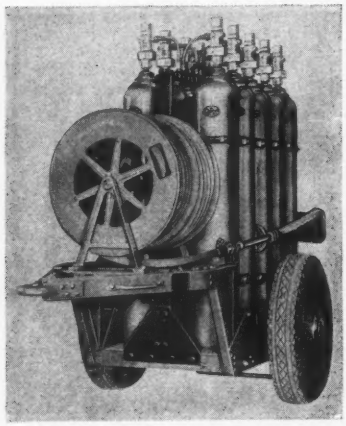
DEVELOPMENT of a lubricated plug valve capable of handling a working pressure of 7500 lb. and tested to 15,000 lb. is announced by Merco Nordstrom Valve Co., Pittsburgh, Pa. It is made of special alloy steel with both plug and interior



contact surfaces faced with Merchrome. This is believed to be the heaviest duty plug valve ever manufactured and is the result of several years of development work in the research laboratories of the manufacturer.

Fire-Fighting Trailer

THE C-O-TWO FIRE EQUIPMENT CO., Newark, N. J. has developed 2 and 4-wheeled C-O-Two Hose Reel Trailer units which are especially practical for the protection of large or widely separated flammable liquid or electrical hazards or wherever the probable location of a fire cannot be determined in advance.



These C-O-Two wheeled units carry as many as ten 50-lb. cylinders of carbon dioxide gas or less, with one or two hose reels with 100, 150 or 200-ft. of high pressure hose and discharge horns fitted with quick-opening valve for controlling the discharge of gas. The unit shown is 109¼ in. long and 48 in. wide. To facilitate easy movement it is mounted on standard size balloon tired wheels and is so balanced that it will not tip over backward. When it is not attached to a mobile unit, it rests upon two short steel supports which fold under the front of the trailer frame when not in use.

Non-Magnetic Steel

A NON-MAGNETIC, free machining alloy steel possessing low magnetic permeability with superior mechanical properties has been developed especially for the electrical industry by the Jessop Steel Co., 725 Green St., Washington, Pa. This steel has a magnetic permeability of only 1.003 to 1.006 at 1000 Oersteds magnetizing force at temperatures from sub-zero to boiling and its high electrical resistance (69 to 71 michrohms per centimeter) considerably reduces current eddy loss. In the annealed condition, the tensile strength is 80,000 to 110,000 lb. per sq. in.; yield point, 35,000 to 60,000 lb.; elongation in 2 in., 25 to 50 per cent; reduction of area, 30 to 60 per cent; Izod impact value (at room temperature), 80 ft. lb.

Boiler Feed System

PLANNED ESPECIALLY for boilers up to 750 hp. and 200 lb. pressure. Westco Automatic Boiler Return Systems just introduced by the Micro-Westco, Inc., 108 State St., Bettendorf, Ia., incorporate a number of exclusive features designed to help reduce fuel consumption, cut labor costs and increase plant efficiency.

These compact systems: automatically return all condensate to the boiler, from both high and low pressure equipment; add make-up water as needed to compensate for loss of live steam; maintain a uniform water level in boiler; keep return lines constantly open; eliminate back pressure on return lines; feature low cost operation and maximum reliability.

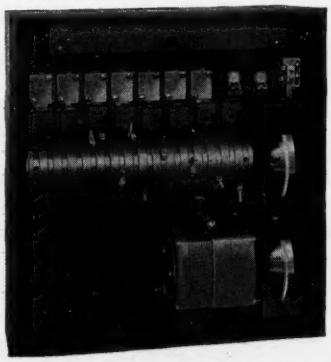
Each combination is equipped with a Westco Turbine-Type Pump having renewable liners. This advanced construction permits alterations in performance without changing the entire unit. Additional equipment includes receiver, stand, thermometer, gauge, make-up valve and strainers.

The automatic boiler water level control performs three vitally important duties. First, it starts and stops the boiler feed pump to maintain the water level in the boiler within a ¾" range. Second, it cuts off the burner or stoker if the water in the boiler should reach a dangerously low level. Third, it can be wired to sound an alarm when the low cut-off point is reached. Control is fitted with Monel float, has specially constructed bellows to eliminate packing, and is constructed with all operating parts isolated from steam and hot water zone.

Flex-O-Timer

PRECISE timing of the sequence and duration of operations involving temperature, pressure, humidity or combinations of each and adaptable for all-electric, all-pneumatic operations, or combinations of both, is possible with the new Taylor Flex-O-Timer, introduced by the Taylor Instrument Cos., Rochester, N. Y.

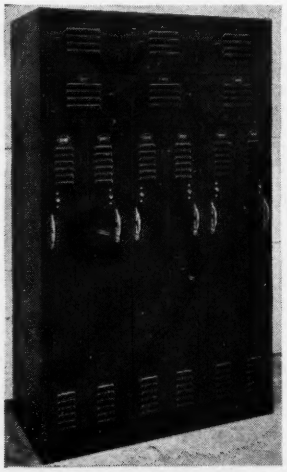
Extreme flexibility is obtained by the use of adjustable pins on the revolving drum. Cam cutting is eliminated and the actuating pins are easily and precisely adjusted in circumferential undercut grooves on the one-piece drum and locked in place with a screw. The air valve or switch can be turned on and off or vice versa, within ½ of 1 per cent of total cycle time by means of this extreme adjustability. Where the diversity of the



products being processed requires considerable variation in processing time, Taylor Flex-O-Timer offers a varying drum speed rotation through a mechanism which provides 78 different drum speeds with each gear train ratio. A new type low leak air valve, used on this new Taylor Flex-O-Timer, is said to utilize 99½ per cent of the air passed through it.

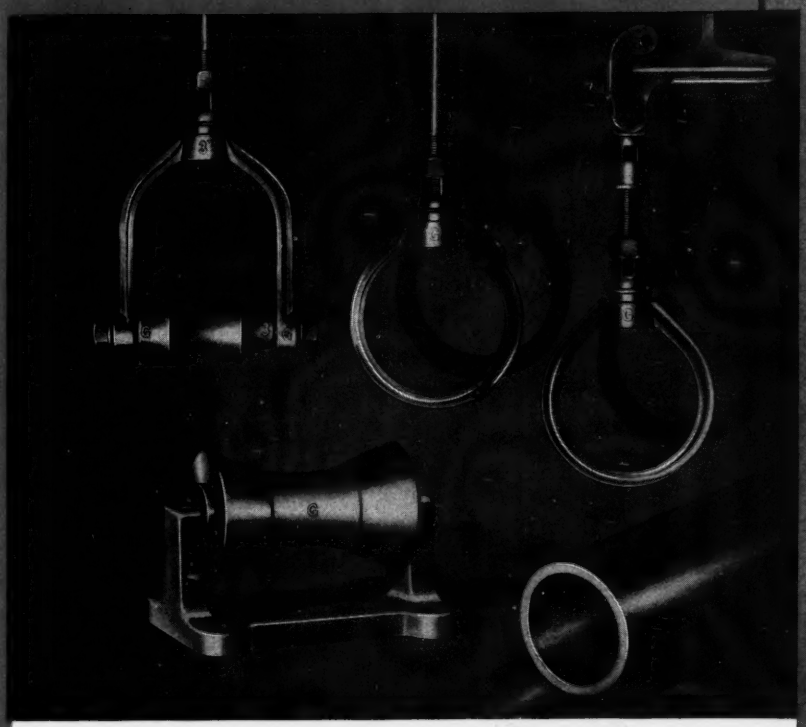
Two-In-One Locker

LOCKERS which cut the required floor space in half and designed for use in cramped quarters or any installation where a saving in floor space is an important consideration are announced by the Penn Metal Corp., Philadelphia, Pa. The illustration shows a group of three lockers affording ample accommodations for six persons.



Each locker is 15 in. wide, 21 in. deep and 73½ in. high, and is divided into two coat compartments, each 7½ in. wide, 21 in. deep and 54 in. high. The two hat compartments are each 15 in. wide, 21 in. deep and 9 in. high. Flat key locks are furnished for each coat compartment door. When opened, it automatically unlocks a hat compartment.

QUICKER, STRONGER, MORE COMPACT...



Hang ANY *Piping* ANYWHERE!

Pipeline hanging is *one* operation where you'll actually save money by doing a top-grade job! Simply select hangers from the Grinnell line . . . it costs no more to do the job "right" than it does to use makeshift hangers. With Grinnell Hangers you'll obtain sturdy, compact, *permanent* installations easily adjustable at any time.

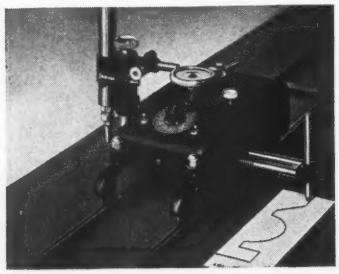
Grinnell Hangers include special types to hang any size of pipe in any position . . . with quick, positive adjustments after installation. Write for complete data-and-specifications catalog, "Grinnell Adjustable Hangers and Supports." Grinnell Company, Inc., Executive Offices, Providence, R. I. Branch offices in principal cities of United States and Canada.

GRINNELL

WHENEVER **PIPING** IS INVOLVED

Portable Cutting Machine

THE HARRIS CALORIFIC CO., Cleveland, O., announce a new and improved Model K portable, motor-driven gas cutting machine.

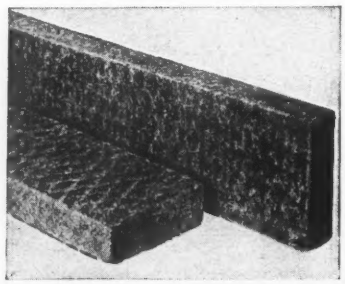


The Model K is powered by a Universal Electric Motor and will cut straight lines of any length, with square or beveled edges; 1 to 86 in. diam. circles with standard equipment; possesses a speed range from 3 to 60 in. per min., forward or reverse. An instant stop feature permits cutting of sharp angles, and a tracing feature provides for cutting irregular forms. Mounting for 2 torches is provided. It weighs 45 lbs. complete with torch.

Many different Harris torches are available for this machine to efficiently use acetylene, propane, natural gas and other fuel gases in combination with oxygen.

Insulating Block

B-H MONO-BLOCK is the name of a new insulating block developed by Baldwin-Hill Co., 577 Klagg Avenue, Trenton, N. J., and suitable for a full range of temperatures up to 1600 deg. F. It is fabricated of B-H Black Rockwool, felted and bonded together to form a semi-hard block that is light in weight, easily cut and fitted around equipment having curved surfaces of large radii as well as flat surfaces. It is especially adapted to boiler walls, breechings, ducts, tanks, towers and similar hot equipment and is



made in lengths from 18 to 36 in., widths from 6 to 12 in. and thicknesses from 1 to 4 in. To facilitate application of this block, it is advisable to use B-H Bond-Tite, a highly efficient adhesive that holds the block in place against the surface being insulated and is effective in sealing porous surfaces.

Air Hose for Hot Oil Service

RECOMMENDED FOR use where excessive hot oil conditions are encountered, The B. F. Goodrich Co., Akron, Ohio, announces the addition of a new air hose made with a snythetic tube and rubber cover. It is known as Type 54.

Laboratory tests indicate that the synthetic tube used in this construction should give two to three times longer service life when exposed to the same conditions as a tube made of natural rubber. The hose is built with a smooth green abrasion resistant cover.

Transfer Screw and Punch Set

A NEW method for transferring screw and stud holes as well as blind drill holes from a drilled surface to another that is to be drilled in duplicate has been perfected in the Neilsen transfer screw and punch sets now available from Neilsen Tool & Die Company, Berkely, Mich. Layout punches are made to transfer drill

holes through a drilled section in diameters from 17/64 to 59/64 in. The punch is made with a case hardened tip that is removable for replacement and, when a solid blow is struck on the punch head, will transfer the drill center and drill circle with complete accuracy. Center and drill circle penetrate steel to a depth of 0.010 in. Transfer screws are made with a shoulder support of uniform height enabling holes of various sizes to be transferred in the same plane at one impression.

Gasket

A NEW kind of gasket which embodies a combination of the desirable properties of asbestos and neoprene has been introduced by Victor Manufacturing & Gasket Co. of Detroit, Mich. The gaskets are made by a new process which results in an entirely different type of product from the usual rubber or neoprene bound asbestos composition commonly known as super-heat packing. These new gaskets are not supplied in sheet form. In the manufacturing process they are first blanked from asbestos sheet material. Then the gasket is coated with a neoprene cement developed especially to increase its resistance to the passage of gases and liquids.

Oil Pressure Unit

A NEW compact oil pressure unit designed for circulating lubricating oil at a predetermined uniform pressure through lantern glands of stuffing boxes, through large bearings, and for supplying oil to hydraulic equipment, heat treating systems or where there is the problem of circulating or supplying oil at a uniform pressure, is announced by the Durametallic Corporation, 2104 Factory Street, Kalamazoo, Michigan. This Oil Puressure Unit features a manual type regulator to provide a circulation up to 1000

lb. pressure, a cooling coil of seamless copper tubing, an oil filter, pressure pump, explosion-proof electric motor, cast iron base, vapor-proof lid, oil tank vent, oil level gage and pressure gage. Unit is supplied complete or as a motor-pump assembly.

Flashlight Extension

THIS device known as the Sierra Flashlight Bulb Extension, is made by the Sierra Aircraft Co., Sierra Madre, Cal., of special wire encased in high-grade aluminum alloy tubing, to aid in making close inspections. The extension has

lengths from 6 to 36 in. Its plug is screwed into any flashlight. Being bendable it can go down into intricate mechanisms or around corners. Engineers and inspectors can make it into a hook or into its own stand so that both hands are free to work with the light at the exact location desired.

FROM HOW FAR CAN YOU SEE THIS LIQUID LEVEL ?

At the right is shown a reproduction from an actual unretouched color photograph which illustrates the appearance of the gauge glass from directly in front.

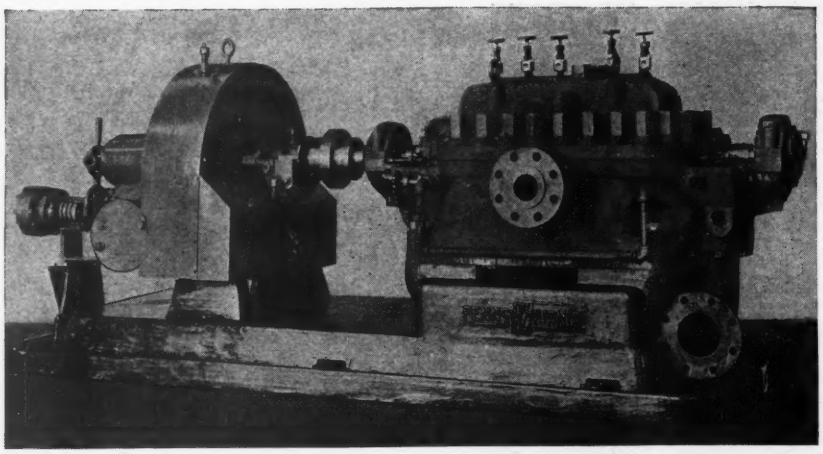
HERE'S a real test of liquid level visibility! Place this gauge glass illustration next to the gauge glass you are now using. Then observe both from varying distances. Note the superior visibility of the liquid level in the illustration and remember—the illustration is a poor substitute for the vivid, unmistakable, liquid level visibility of an actual "PYREX" Broad Red Line Gauge Glass.

But visibility alone is not enough. A gauge glass that will give a long life of economical service must have machine drawn accuracy that avoids installation strains; chemical stability that resists the solvent action of steam; resistance to sudden temperature changes; mechanical strength that reduces breakage. That's exactly what you get in all "PYREX" Gauge Glasses.

An actual test of the gauge glass itself is your best proof of its true value. Your dealer will gladly cooperate. Ask him for full details. "PYREX" and Corning Gauge Glasses are stocked by leading steam and mill supply houses. Corning Glass Works, Corning, N. Y.

CORNING
Glass Works
Corning, New York

Pyrex Gauge Glasses

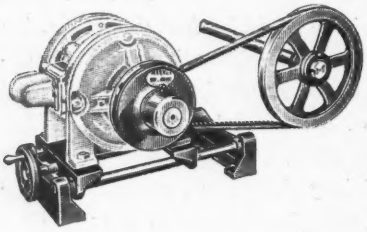


Centrifugal Pump

THE ACCOMPANYING illustration shows a 3 in. 5 stage pump made by the Pennsylvania Pump & Compressor Co. to meet the exacting needs of boiler feed duty and to resist the surge and wash of hot boiler water. The casing is of a close-grained pressure-tight nickel alloy cast iron, containing, on an average, 1.50 per cent nickel, 0.50 per cent molybdenum and 0.25 per cent chromium, with a tensile strength exceeding 45,000 p.s.i. Certain of the wearing parts are also made of this alloy, cast iron which is produced by R. Hoe & Co., New York, N. Y.

Variable Speed Control

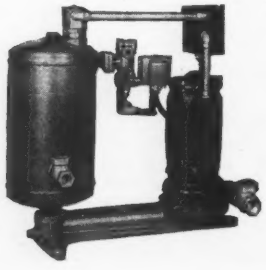
REEVES PULLEY Co., Columbus, Ind., announces the addition of the Reeves Vari-Speed Jr. to its line of variable speed control equipment. By means of this low-cost unit, any standard constant speed motor of from fractional to 1½ hp. is easily and inexpensively converted into a variable speed unit to provide complete speed adjustability for the machine it drives. No special shaft extension is required.



The Vari-Speed Jr. is built in six different sizes of disc assembly, for use with motors of from ⅛ to 1½ hp. and provides speed control over a range of from 1¾ : 1 to 2¾ ; 1, inclusive, depending upon the size, HP and speed of unit selected. Two sizes of motor bases are available, according to the size of motor. Either size base may be used with any one of the six disc assemblies.

Boiler Feed Pump

THE NEW No. 30SH Boiler Feed Pump, announced by the Johnson Corp., introduces to dry cleaners, dairies, laundries and all operators of small steam plants, the "pressure equalizing" principle of boiler feeding.



The Johnson Pressure equalizing pump admits boiler pressure into the pump receiver, much like a return trap. With pressure on both sides of the pump thus equalized all the work that remains for the pump raising the condensate a few feet to the boiler water level. The new 30SH pump for instance is suitable for use with a 30 hp. boiler, yet requires only a ⅓ hp. motor.

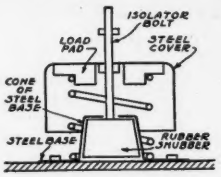
In addition to making the pump's job easier this pressure on the suction allows the pump to handle condensate as hot as 300 deg. F. without danger of vapor binding.

The pump consists of a cylindrical receiving chamber and a vertical, close coupled, centrifugal pump mounted on a cast iron base. Stationary electrodes are suspended into the top of the receiver and control a solenoid-operated valve which is mounted between pump and receiver.

Machine-Vibration Isolator

A NEW vibration isolator, designed to economically control machine vibration and reduce the resulting noise, was recently announced by Johns-Manville, 22 East 40th St., New York, N. Y. The

device, known as the J-M Controlled Spring Isolator, was developed for use where vibration and excessive motion create noise and tend to wear out machine parts and damage connections as well as crack the supporting walls and floors. Working parts of the unit consist of a coil spring and a rubber load pad, which support the equipment and isolate vibration, and an adjustable rubber snubber inside the base, which controls excessive motion. The isolator was built to take care of horizontal and torsional as well as vertical vibration, and tests by the J-M Research Laboratories, where the unit was developed, indicate it to be particularly efficient for the low frequency vibrations resulting from slow speeds and from many operations involving reciprocal action. The load pad is



designed to overcome any high frequency vibrations. It is made in two sizes: light duty, for loads from 60 to 190 lb. per isolator; and heavy duty for loads from 250 to 720 lb. per isolator. Heavy machines may be isolated by clusters of the units.

Sealing Compound

KEY PASTE, the Graphite sealing compound for thread and gasket connections on lines carrying hot or cold oily liquids, high pressure steam lines and boiler connections, is now available in a new handy Kit Size can with a brush applicator in the lid according to the manufacturers, the Key Co., 2653 McCasland Ave., East St. Louis, Ill. This new package containing ⅝ lb. of Key Graphite Paste is approximately 2½ in. in diameter by 4 in. tall and can be conveniently carried in tool kit or tool box. Inside, attached to the lid, is the brush applicator which eliminates the need for paddle, stick or extra brush to apply the compound on the thread or gasket. The new container sells at 40 ct. and, for a limited time, three ¼ lb. cans are offered at one dollar to introduce the new package.

CONSTRUCTION was started recently on a complete production plant at Milford, Conn., by U. S. Electrical Motors, Inc., a California concern. The site is on the main line of the New York, New Haven and Hartford Railroad, 63 mi. from New York city and the plant, of modern monitor type brick and steel construction, will be completed in November. Design and erection is under the supervision of Lew F. Caproni, architect and engineer of New Haven.

CONTROL OF TEMPERATURES IN BENDING FURNACE.
X-RAY INSPECTION OF WELDS.
HYDROSTATIC TEST.
INSPECTION FOR GRAIN SIZE.
MAINTENANCE OF HEAT DURING WELDING.
CONTROL OF ANNEALING TEMPERATURES.
STRESS RELIEVING AFTER WELDING.

CONTROL in Power Piping Fabrication

ALL of the facilities and equipment for the fabrication and control of High Pressure-High Temperature Piping are included within the Blaw-Knox organization. Plants, special machinery, laboratories and highly skilled personnel enable every procedure necessary for the best of piping fabrication to be carried on without the necessity for subletting portions of the contract to secure the use of outside facilities.

BLAW-KNOX COMPANY
POWER PIPING DIVISION
PENNSYLVANIA AVENUE, PITTSBURGH,

BOOK
distribution FLEX
by E. A. Wert and S.
sored by Power Piping Divisi
Blaw-Knox Co.
It is now possible for engineers u
this book to figure stresses in h
pressure-high temperature piping s
tems by means of graphs and high
simplified formulae. This book is pri
$3.00 but will be sent gra
who ask for it
heads.

News from the Field

J. E. Sirrine & Co. have awarded to Henry B. McKoy Co. the contract for the erection of the boiler room, coal pocket, and underground ducts at the Greenville Woman's College, Division of Furman University. The boiler room will be 37 by 28 ft., and will have adjacent underground coal pocket, 25 by 28 ft. Construction will be in general, concrete and brick walls, steel beams, steel sash, wooden roof decking, and tar and gravel roofing. The contract also includes building approximately 600 ft. of concrete and tile ducts for steam mains.

An Electrical Engineering Exposition designed to serve the electrical industry by promoting a more rapid dissemination of information on new developments in electrical engineering, will be held in Convention Hall, Philadelphia, the same week as the mid-winter meetings of the A.I.E.E., January 27 to 31.

Hoffman Combustion Engineering Co. announces the appointment of Charles C. Plummer as vice-president in charge of the Western Division, with headquarters at Chicago, Ill.

Frank Hoke, president of the Stoker Manufacturers Association, and Vice President of Holcomb & Hoke Mfg. Co. has announced the following appointments of chairmen of standing committee of the Association for the ensuing year: Advertising and Public Relations—J. M. McClintock, chairman, Illinois Iron & Bolt Co.

Business Standards Committee—A. D. Scoville, chairman, Cotta Transmission Corp. Commercial Committee—B. O. Fink, chairman, Auburn Foundry, Inc. Legislative Committee—R. C. Goddard, chairman, Combustioneer Division, Steel Products Engineering Co. Engineering and Research Committee—E. C. Webb, chairman, Iron Firemen Mfg. Co. Ways and Means Committee—J. E. Martin, chairman, Link-Belt Co. Traffic Committee—C. J. Incrocci, chairman, Link-Belt Co.

Dr. W. D. Coolidge, director of the General Electric Research Laboratory, has been named to the newly organized National Inventors' Council, a body created by Secretary of Commerce Harry Hopkins to encourage civilian inventions as part of the national defense program. The Council, composed of twelve scientists and industrial leaders, will co-operate with the National Defense Research Committee.

Plandaire, Inc., has announced the appointment of Clifford R. Hutcheon as chief engineer. He will be in complete charge of production, research and development and will head a staff of experienced engineers who are all specialists on engineered air distribution.

Dr. F. E. Giesecke, College Station, Texas, President of the A. S. H. & V. E., announces that the first Society meeting ever held in Texas will be the 1940 Fall Meeting, October 14 and 15 at the Rice Hotel, Houston, Tex. The Council has authorized a two-day session at which six technical papers will be presented.

Arrangements for the meeting and the entertainment of visiting members will be directed by C. A. McKinney, General Chairman, assisted by the following Committee Chairmen, J. V. O. Weaver, vice-chairman; J. A. Walsh, publicity; W. R. Etie, transportation; I. A. Naman, tours; A. M. Chase, Jr., banquet; D. S. Cooper, registration; A. B. Banowsky, entertainment; R. F. Taylor, finance; A. F. Barnes, ladies; and G. D. Maves, sports.

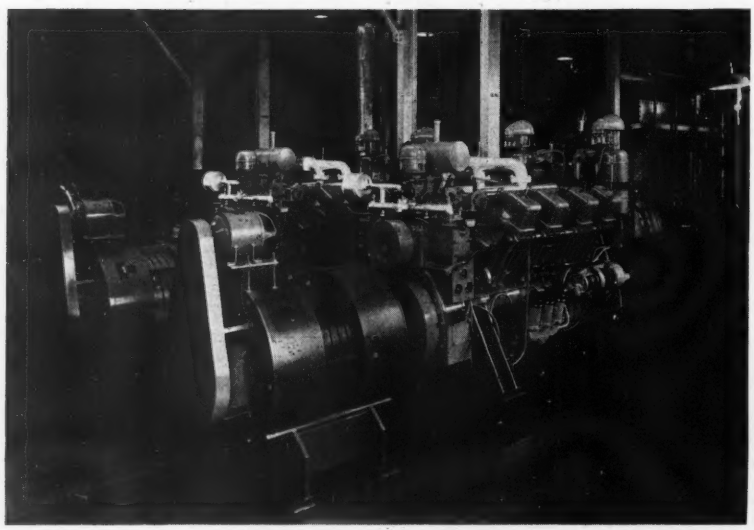
John Lowell Fyke, 55, General Superintendent of Allis-Chalmers Mfg. Co.'s electrical and steam turbine shops at their West Allis Works since 1935, died suddenly at his home on July 24. He was a graduate of Ohio State, and was with the company since 1905.

P. Jones, manager of the New York sales office of Cutler-Hammer, Inc., announces the appointment of Mr. R. Volbrecht to the New York Merchandising Sales staff.

Work to Start on Fort Peck Hydroelectric Plant

The Untied States Engineer Office, Missouri River Division, Kansas City, Mo., has awarded contract to Woods Brothers Construction Co., 132 South Thirteenth Street, Lincoln, Neb., for construction of power house substructure at the Fort Peck power dam, Fort Peck, Mont. Company recently submitted low bid of $410,675. Work is scheduled to proceed at once and will require the excavation of about 16,000 cu. yd. of shale at site; construction calls for approximately 2,000,000 lb. of reinforcing steel, 25,000 cu. yd. of concrete, and about 300,000 lb. of miscellaneous steel construction and piping, the latter varying up to 14 ft. 6 in. in diameter. Plans are under way for station superstructure, for which bids are expected to be called in the near future. The power station will be situated at the outlet portal of tunnel No. 1, and will have an initial installation of 50,000-kw., divided into one 35,000-kw. and one 15,000-kw. units; these will be driven by hydraulic turbines with rated capacities of 50,000-hp. and 20,000-hp., respectively. The generators will furnish 60-cycle current to a three-phase line system, operating at 13,800-v. On recent call for bids, award for the electric generators was made to Allis-Chalmers Mfg. Co., Milwaukee, Wis., and for the hydraulic turbines to S. Morgan Smith Co., York, Pa., with governors for the latter to be furnished by the Woodward Governor Co., Rockford, Ill.

The Fort Peck project is designed to provide notable assistance in the development both of the Missouri River valley, in the vicinity of the dam, and the Yellowstone River valley, the latter emptying into the Missouri River a few miles below the dam. It will supply low-cost power for irrigation and other work, and will lead to the installation of numerous electric-operated pumping stations and other facilities for land development.



Small Diesels Increase Plant Flexibility

These two 900 r.p.m. Caterpillar Diesels, each driving a 100 kw. Electric Machinery generator were put in service June 1 in the Russell, Burdsall & Ward Bolt & Nut plant at Rock Falls, Ill. In the background are two MacIntosh & Seymore's, one 750 and the other 275 kw. used for heavy load service. The new Caterpillars serve as standby, replace public utility week end service and are used in parallel with the larger engines to give a flexible power set-up with high efficiency from 50 kw. to the peak capacity of the station

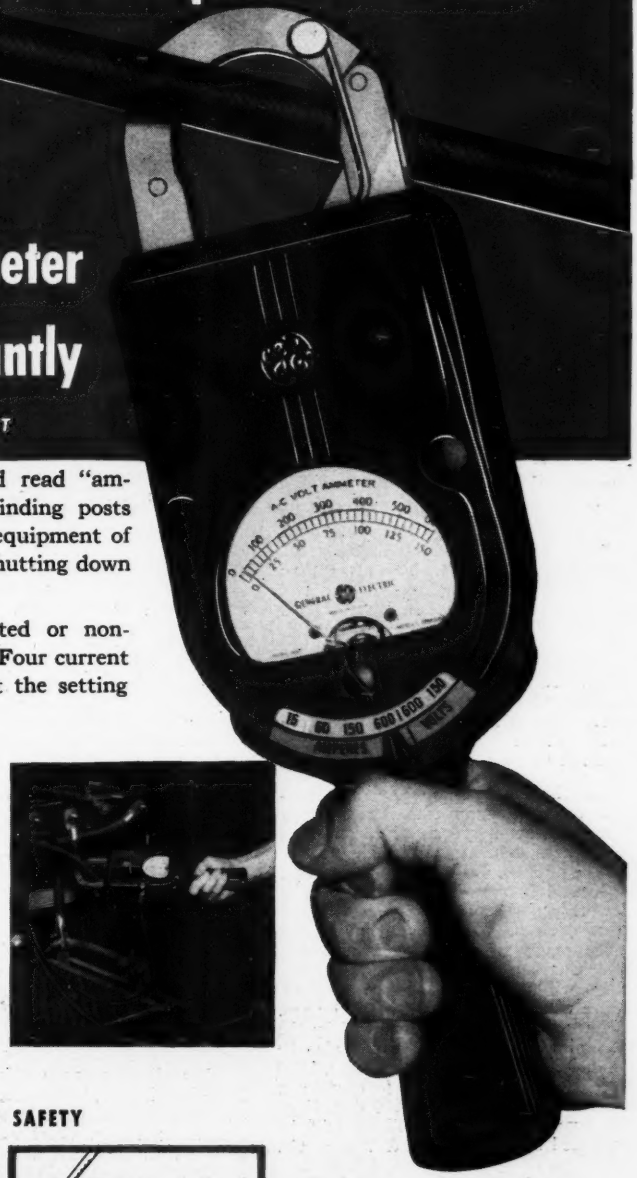
No Cutting of Conductors
No Interruption of Service

The

NEW

G-E Hook-on Volt-ammeter
Measures Current Instantly

TYPE AK-1, FOR ALTERNATING CURRENT



JUST hook the instrument around the line and read "amperes." Or, connect leads to the convenient binding posts and read "volts." There's no need for additional equipment of any kind—no necessity for cutting conductors or shutting down equipment.

You can measure alternating current in insulated or non-insulated conductors up to two inches in diameter. Four current ranges, 0–15/60/150/600 amperes, are available at the setting of a plainly marked range-selector switch.

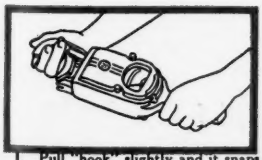
This low-priced instrument is small enough to get into tight places, light enough to be carried on a lineman's belt, and accurate enough for a great variety of measuring jobs.

A Single Set-up for Current and Voltage

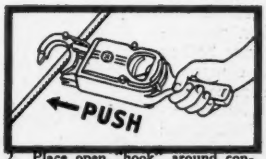
Two voltage ranges, 0–150/600 volts, are also provided. Just set the switch to the desired voltage range, then connect leads to the terminals on the front of the instrument. (Voltage leads are furnished with each instrument.)

Leaving the voltage leads connected does not affect current readings. Just read the "amps," then flick the switch and read "volts."

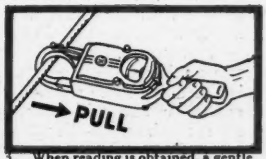
PUSH-PULL OPERATION GIVES TRIGGERLESS SAFETY



1. Pull "hook" slightly and it snaps open. No trigger to pinch fingers.



2. Place open "hook" around conductor; a slight push on handle snaps it shut, and instrument is ready for reading.



3. When reading is obtained, a gentle pull on handle opens dovetail joint and releases conductor. No trigger connected to live parts.

Send for This Free Bulletin Today

Our bulletin GEA-2950 gives complete information about this time-saving instrument. Call your G-E Office or write General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

602-11

MAX W. BABB, president of Allis-Chalmers Mfg. Co., has announced the appointment of F. J. Geiger to the position of assistant manager of the electrical department, in which capacity he will be in complete charge of sales and engineering at the company's Norwood, Ohio plant. Frank R. Freyler, now in the company's Philadelphia office, will be transferred to the Norwood plant to take over Mr. Geiger's former duties as assistant manager of sales. E. C. George, who has been acting as works manager of the Norwood Plant and A. Thorsen, who has been acting as assitanst works manager, have both been officially appointed to those respective positions.

THE APPOINTMENT of William C. Bennett as Manager of the newly created Appliance Sales Division of Cochrane Corp. has been announced by H. E. Sibson, vice-president and general sales manager. John E. Fearon has been placed in charge of the flow meter sales section to coordinate sales and engineering and assist Mr. Bennett both in maintaining close personal contact with sales representatives and in developing of meter sales promotion. Edward J. Glinske is placed in charge of application engineering, proposals, and order details in the specialties section.

D. H. SKEEN & Co., 1 North La Salle Street, Chicago, Ill., appointed sales representatives of Thomas C. Wilson, Inc., Long Island City, N. Y. in northern Illinois, eastern Iowa, Indiana—north of and including the city of Indianapolis, and southern Wisconsin.

BRADSHAW & Co., Pittsburgh, Pa., has been appointed General Sales Agents for the national distribution of the W-K-M Master Scrubber for producing clean, dry steam, air or gas. They will appoint agents in various key cities.

Lee G. Warren, who was project manager on Chickamauga and Watts Bar dams, will be in charge of construction of the new dam as project manager.

The new 120,000 kw. steam plant will be located in the vicinitv of the Watts Bar project. About 18 mo. will be needed to complete the plant, and it is expected to be ready for operation in January, 1942. Charles T. Main, Inc., of Boston, Mass., will act as consultants on the plant. There will be two 60,000 kw. 1800 r.p.m. steam turbo-generators, furnished by the General Electric Co. There will also be two 600,000 lb. per hr. steam boilers, 1,000 p.s.i. gage design pressure to operate at 875 to 900 p.s.i. gage and 900 deg. F. at the superheater outlet. These will be furnished by the Babcock & Wilcox Co.

TVA Expands Steam and Hydro

WORK was started August 1 on expansions authorized by Congress to increase the TVA installed power capacity by 300,000 kw. Congress acted upon the recommendation of the Council of National Defense that the power is urgently needed to provide for greatly expanded national defense needs in the Tennessee Valley, including large quantities of aluminum for airplanes.

The $25,000,000 voted by Congress is intended to: begin construction of the Cherokee Dam on the Holston River in Tennessee; to build a new steam plant with a capacity of 120,000 kw.; and, to provide for the installation of additional generators at Wilson and Pickwick Landing dams.

Cherokee Dam will have an installation of 90,000 kw., consisting of three units of 30,000 kw. each. In addition, there will be installed units of approximately 90,000 kw. capacity at downstream dams in the Muscle Shoals area, consisting of two 26,000 kw. units at Wilson and one 36,000 kw. unit at Pickwick Landing.

These units will be required to obtain the capacity justified by the storage in Cherokee reservoir. They are in addition to two 26,000 kw. units at Wilson, two 32,000 kw. units at Wheeler, and one 36,000 kw. unit at Pickwick Landing dams which are now being installed.

The new Cherokee Dam will be about 6,600 ft. long and 170 ft. high, measured from the rock foundation. It will consist of a concrete gravity section about 1,825 ft. long, including the 424 ft. spillway, and about 4,800 ft. of earth enbankments. Two earth dikes, each about 700 ft. long, will be required across saddles at the south end of the dam. Approximately 725,000 cu. yd. of concrete and 3,000,000 cu. yd. of earth fill will be required in construction of the project.

This dam will control the flow from 3,428 sq. mi., more than 90 per cent of the Holston River basin. When filled to the top of the gates, the reservoir will cover 30,000 a., be 45 mi. long, have a shoreline of about 400 mi. and a total storage of 1,500,000 a. ft. of which 1,200,000 a. ft. will be controlled. The dam is scheduled for completion so that the reservoir can be filled during the spring rains of 1942, with storage to be started about January 1, 1942. The site of the dam is about 52 mi. above the mouth of the Holston River which meets the French Broad River about 5 mi. above Knoxville to form the Tennessee River. The dam site is about 33 mi. from Knoxville by highway, and the largest nearby town is Jefferson City, 2.5 mi. south.

Philadelphia Electric to Continue Expansion at Chester Station

THE PHILADELPHIA ELECTRIC CO., Philadelphia, Pa., has authorized further expansion at its Chester steam-electric generating station, where work is now in progress on an addition to provide for the installation of a 50,000-kw. turbine-generator unit, two high-pressure boilers and auxiliary equipment. The equipment is scheduled to be ready for service early next year and will represent an investment of about $7,000,000. The additional expansion, to follow completion of present development, will include the installation of a new 80,000-kw. turbine-generator unit and auxiliaries, for which award has just been made to Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; the unit will be of low-pressure type and with accessory equipment is estimated to cost about $4,600,000, bringing the cost of the expansion to $11,600,000, practically all of which is for the increase in power resources in the entire Philadelphia metropolitan area.

Tyler Carlisle Dead

TYLER W. CARLISLE, 54, president of the Strong, Carlisle & Hammond Co., died in Cleveland, O., on August 14 after an illness of about a year.

Mr. Carlisle was born in Cleveland in 1885. He attended the Masachusetts Institute of Technology and after an apprenticeship in an eastern factory went to work for the Strong, Carlisle & Hammond Co. in 1913. His father, Robert H. Carlisle was one of the founders of this company.

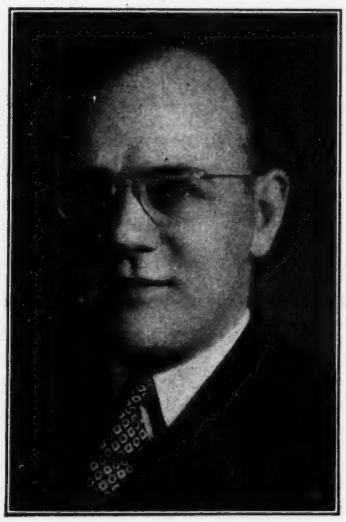
Serving in the World War as a major in the ordnance department, Mr. Carlisle returned to this company as general sales manager and in 1926, shortly after the death of his father, was elected vice president and in 1937 president.

Tyler Carlisle was a trustee of the Cleveland Protestant Orphan Asylum and the Community Fund and a member of the Union Club, Chamber of Commerce, Hermit Club and the Mayfield Country Club.

Surviving are his wife, Mrs. Hazel Kirk Carlisle, and two daughters, Jean and Ann.

Clinton E. Stryker

CLINTON E. STRYKER has been appointed vice-president and assistant to the president of the Nordberg Mfg. Co., Milwaukee, Wis. He graduated from the



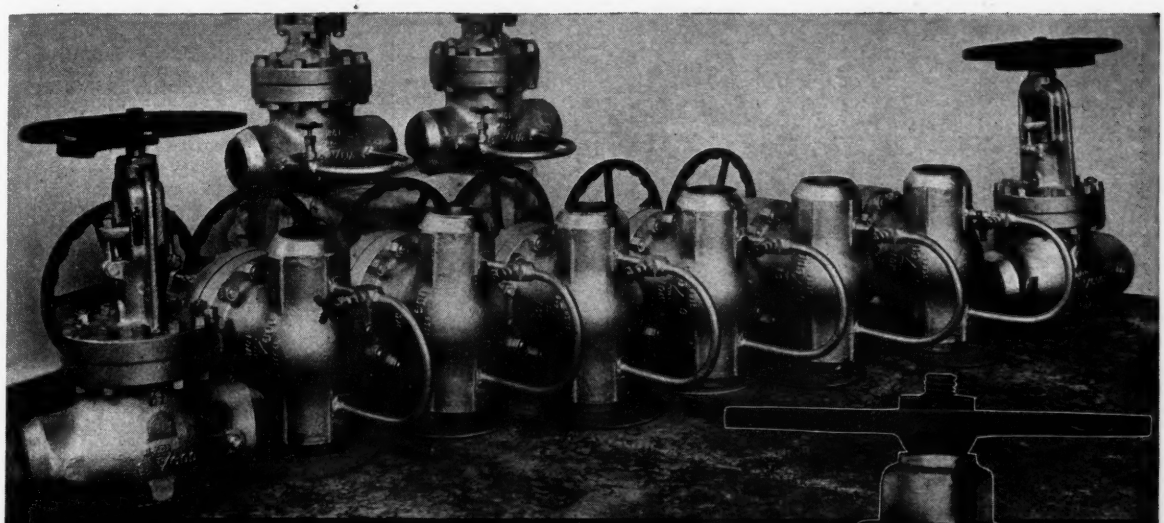
Clinton E. Stryker

Armour Institute of Technology in 1917 and is a Fellow of the A.I.E.E. and a member of the S.A.E.

Unit Ordered for Boulder Dam

POWER equipment for another generating unit at the Boulder Dam power plant, already the world's largest hydro-electric plant and operating at a little more than half capacity, has been ordered. Two contracts were awarded for the purchase of the equipment.

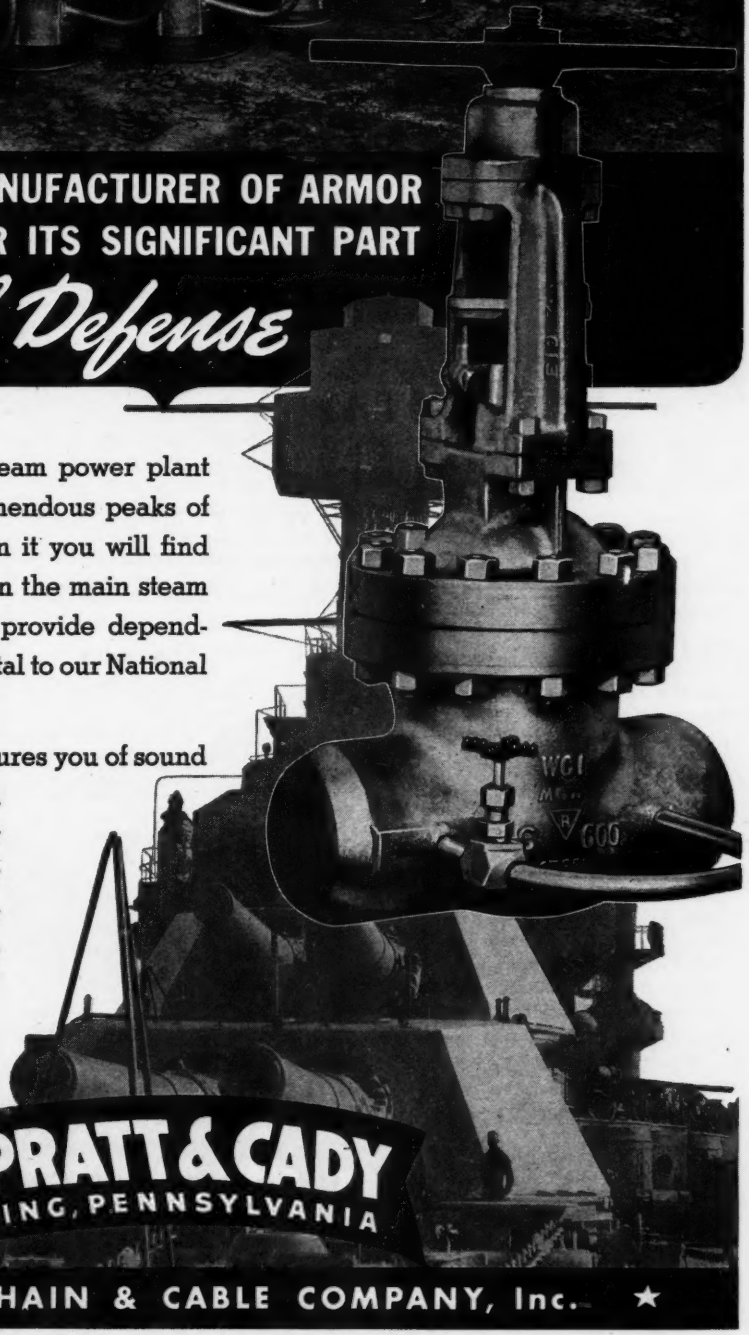
A contfact for furnishing a 115,000-hp. turbine and pressure regulator was awarded to the Allis-Chalmers Mfg. Co. of Milwaukee, Wis., on the Company's



THE LARGEST MANUFACTURER OF ARMOR PLATE PREPARES FOR ITS SIGNIFICANT PART IN *National Defense*

★ In this great mill a new steam power plant was made ready to meet tremendous peaks of future power demand. And in it you will find **Reading-Pratt & Cady Valves** on the main steam and boiler lines where they provide dependable, trouble-free service so vital to our National Preparedness.

Acceptance such as this assures you of sound recommendations when you ask Reading-Pratt & Cady for valves to help work out your plans for greater output, lower KW production cost and lower valve maintenance cost.



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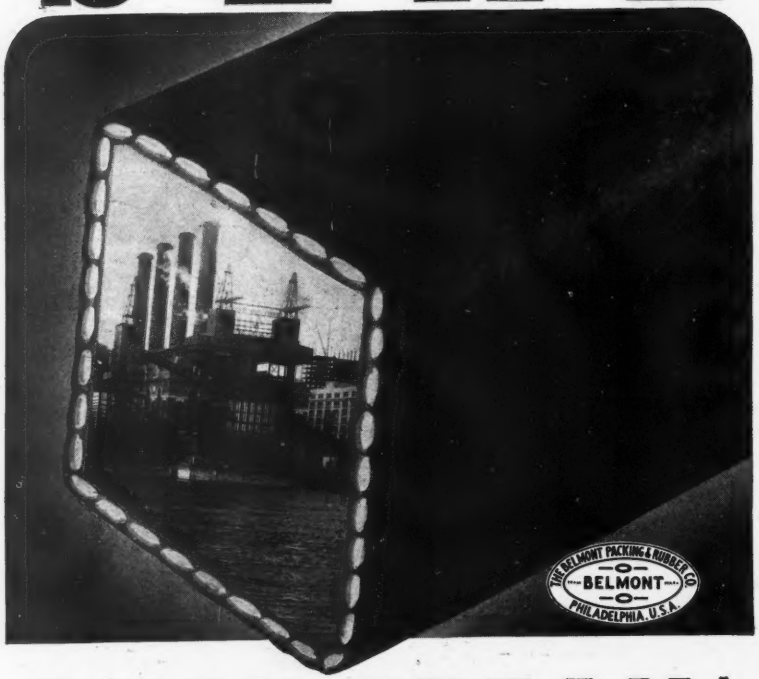
★ AMERICAN CHAIN & CABLE COMPANY, Inc. ★

SEAL



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PACK WITH BELMONT

Keep your pressure! Use a packing designed for high pressure steam service.

The packing illustrated above, Belmont 30, offers a unique center construction. Center block is pleated upon itself, accordion fashion, at an angle of approximately 90 degrees with the rod. This provides high resiliency—abundance of take-up on the gland, and ultimate "edge wear" (longer life) on the block.

All Belmont packings are constructed to give maximum economical service under the most rigorous conditions. No matter for what service you buy a Belmont packing, you'll find it made with the same fine care and attention to detail that distinguishes Belmont 30. See the complete line of Belmont packings in the new 1940 catalog. A request on your company letterhead brings it absolutely FREE.

Suggested Belmont Packings For Steam Service

BELMONT 30

High Pressure Packing. Made of closely woven asbestos cloth frictioned with a heat-resisting rubber compound. Unique accordion-pleated center block. Rubber cushion remains resilient even under extreme temperatures. Comes lubricated and graphited unless otherwise specified. (Rubber cushion omitted in packing space sizes smaller than $\frac{1}{16}$".)

BELMONT 754

Square Braided Packing. Made of long fibre asbestos yarn, with a fine copper wire twisted with each strand. Braided, in same manner as square braided flax packings. Each strand of metallic yarn is thoroughly lubricated and graphited, resulting in a finished packing which lessens possibility of hardening in service.

THERE'S A BELMONT PACKING FOR EVERY SERVICE

BELMONT
PACKINGS

THE BELMONT PACKING & RUBBER COMPANY
BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

bid of $585,000. The contractor is required to deliver the equipment within 530 days.

The Woodward Governor Co. of Rockford, Ill., on its bid of $25,500 was awarded the contract for furnishing a governor with pumping equipment for regulating the speed of the 115,000-hp. turbine. This equipment must also be delivered within 530 days.

These were the two lowest bids for the respective items of four proposals received and opened by the Bureau of Reclamation at its Denver, Colorado, office on July 17.

This equipment is for the large unit designated as A-5 to be installed in the Arizona wing of the U-shaped powerhouse where already are operating 8 of the large 115,000-hp. and one smaller 55,000-hp. units. Six of the large units, N-1 to N-6 inclusive, are in the Nevada wing and 2 of the large ones, A-6 and A-7, and the small one, A-8, are in the Arizona wing. Equipment is also on order for two more of the large units for this wing, A-1 and A-2.

Turbine Orders Hit New High

MARINE and land turbine-equipment ordered from General Electric during the first 6 mo. of 1940 totalled more than 2,000,000 hp., according to E. O. Shreve, vice president in charge of sales, who said further that "The half-year volume of turbine business exceeds that of any comparable period in the company's history."

Slightly more than half of this has been ordered by utilities and industrials. The remainder is made up of marine equipments ordered to provide propulsion for 25 new Navy and merchant vessels.

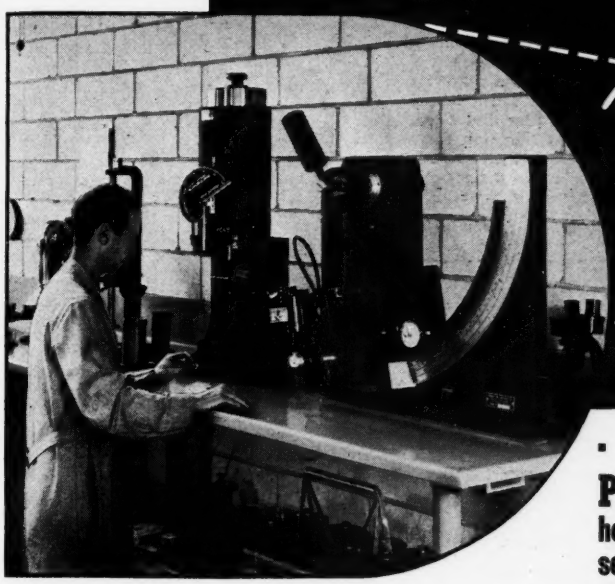
A geographical analysis of the utility and industrial turbine-generators ordered indicates a general distribution over the eastern part of the country with some concentration in heavy manufacturing areas.

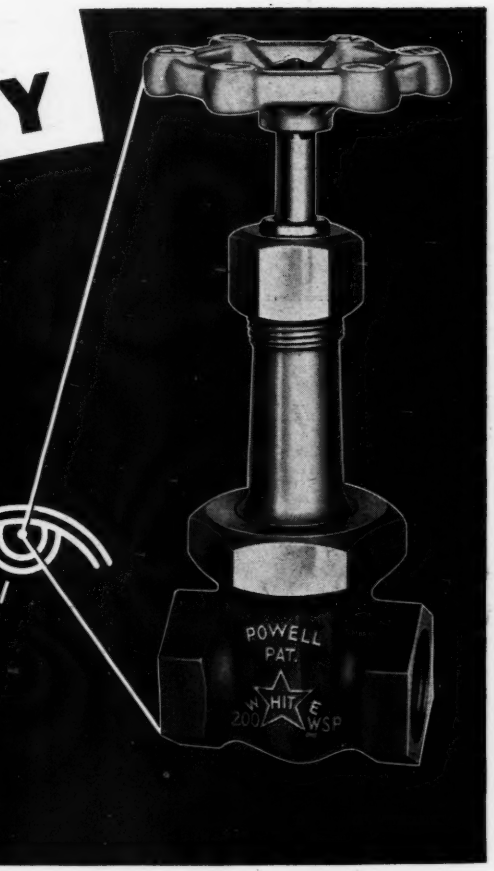
Largest of the land equipments ordered is an 85,000-kw. machine for installation at the Cabin Creek (W. Va.) Station of the American Gas & Elec. Co. Other large units in the lot include a 75,000-kw. job for Detroit Edison; a 65,000-kw. machine for Cincinnati Gas & Elec.; a 60,000-kw. machine for Georgia Power; and a 60,000-kw. unit for Cleveland Electric.

Virginia Electric & Power To Expend $4,000,000 For Plant Addition

THE VIRGINIA ELECTRIC & POWER CO., Richmond, Va., has approved plans for new addition to steam-electric generating station at Norfolk, Va., designed to increase present capacity over 50 per cent. Work will include installation of a new 40,000-kw. turbine-generator unit, high-pressure boiler and complete auxiliary equipment, and is estimated to cost about $4,000,000, including expansion in switchyard structure and other facilities. It is proposed to begin work on project at once, with completion late in 1941. In conjunction with this expansion, company also will make extensions in transmission lines, power substations and distribution lines. An immediate separate line project will be carried out in cooperation with the Virginia Public Service Co., Charlottesville, Va., to provide for ex-

There's more to POWELL QUALITY than meets the BUYER'S EYE!





. . . WATCH, WHILE THIS PRECISION TESTING MACHINE

helps assure ever finer castings through scientific selection of improved moulding and core sands

• It's just one of *many* pieces of equipment to be found in our laboratory . . . but it plays an important role in imparting to Powell products that inherent quality which assures an extra margin of service when the "going" gets tough.

Only the finest moulds can assure sound, perfectly formed castings, and at Powell, we do everything within our power to see that this phase of our production is as nearly perfect as it is humanly possible to make it. Our constant experimentation, therefore, to develop compounds of superior moulding characteristics, may never become a *visible* feature of the finished product, but you can be sure it's an ever-present quality, just the same . . . one that warrants added confidence in its ability to serve you.

Surely, this evidence of underlying quality, originating within our walls long before the product itself materializes, is an important buying consideration . . . it undoubtedly accounts for part of the fact that Powell valves are "the accepted standard throughout industry."

POWELL VALVES

THE WM. POWELL COMPANY • CINCINNATI, OHIO

You Need More Than a Photograph of the Finished Product to See ALL of the Qualities that Make Powell Valves Uniquely Able to Better Serve the Power Engineer

The
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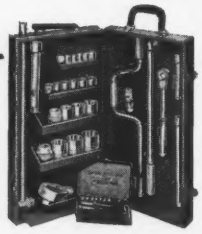
is the
Fastest with
SNAP-ON TOOLS



When the "pressure is on", make every move count . . . with Snap-on tools. Reach safely and surely into tight places, turn tough nuts quickly, handle any hand-tool problem expertly and safely—by choosing *your* tools from Snap-on's line of 2200 precision-built styles and sizes. Built by engineers *for* engineers, Snap-on tools are the modern tools for speedier production and maintenance . . . the *safe* tools for all plant requirements. For catalog and full information, write . . .

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Wrenches
The Best Tools are the Safest Tools

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Dept. PPE-9
Kenosha, Wisconsin

Totalize Steam Flow Accurately

WITH THE
SIMPLEX GYROMETER

Accurate knowledge of all flows, irrespective of the service involved, is necessary if economical overall plant operation is to be obtained.

The Gyrometer, because of its low first cost and minimum maintenance requirements, NOW offers a means of metering services that have previously been neglected.

Let us show you how the Gyrometer can help you to make operating savings.

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6780 Upland St., Philadelphia, Pa.

change of power between the generating station of the latter company at Hampton, Va., and the power plant of the Virginia Electric Company at Richmond. This will be developed with construction of a new 110,000-v. transmission line between the two points, estimated to cost about $2,000,000, with switching stations and other operating facilities. Construction is scheduled at once.

Two 60,000-kw. Steam Turbine-Generators For TVA

Two 60,000-kilowatt turbine-generators for a new steam power plant have been ordered from the General Electric Company by the TVA in its $65,800,000 program to gear its power-generating facilities to national defense needs.

General Electric will build the two steam turbines to almost the same specifications as two units the company is now making for a utility customer, although different power-factor and voltage conditions require some changes in the generators.

The new station, to be located at Watts Bar, near Chattanooga, is expected to be in operation soon after the first of the year in 1942.

Each of the two turbine units will be supplied with steam at 850 pounds pressure and a temperature of 900 F.

Synthetic Rubber Compound

A NEW all-purpose snythetic rubber compound which permanently retains its adhesion, elasticity and waterproofing qualities has been introduced by American Bar Lock Co., Inc., Long Island City, N. Y. Called ABLO Synthetic Rubber Compound, the product contains no disintegrating resins, asphalt or putty, and is applied cold with a gun or trowel.

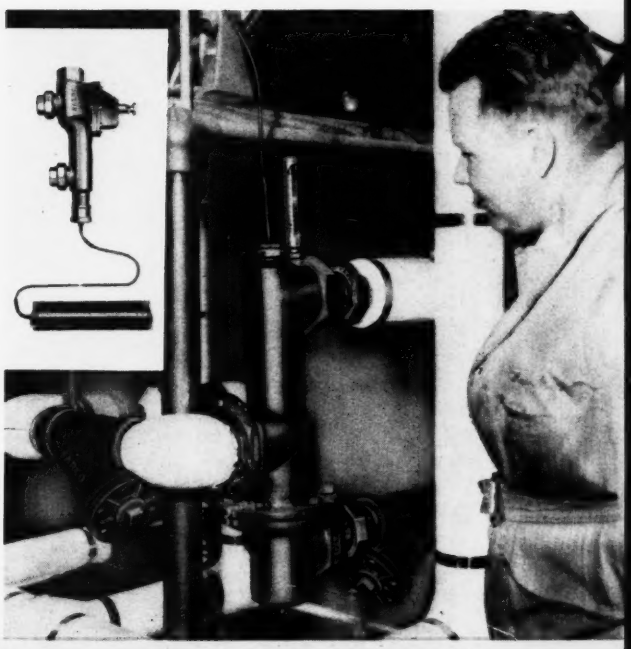
Absolutely watertight, it adheres permanently to wood, stone, brick, concrete, metal, glass and other surfaces. It is supplied in cartridges for use with the manufacturer's special convertible cartridge gun, or in 1 or 5 gal. cans and 55-gal. drums. It may also be obtained in a heavy paint consistency for painting, waterproofing, rustproofing and preserving work. Eight cartridges (1 gal.) of compound and a cartridge gun are offered in a low-price introductory combination.

SPECIALIZED compounds of natural rubber and synthetic rubber with a high degree of electrical conductivity have been recently developed by its laboratory research chemists, it is announced by The B. F. Goodrich Co., Akron, O.

The company also announces that it can now furnish solutions of synthetic rubber which can be applied to the surfaces of natural rubber products like paint, and which will carry away static. This material has already had successful application as belt dressing to carry away static from transmission belts. Natural rubber, unless specially compounded has the highest electrical resistance of any solid material. For conducting static a certain amount of resistance is desirable, since it prevents sparking, and the specialized compounds, both in synthetic and natural rubber, allow the resistance needed to added as a characteristic of the material.

SARCOTHERM

THE NEWEST MEMBER OF THE SARCO HEATING FAMILY*



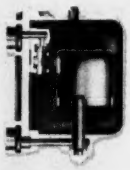
You are familiar with the Sarco Water Blender which mixes hot and cold water and delivers at any predetermined temperature regardless of the varying temperatures of the two sources of supply.

The new SARCOTHERM Hot Water Heating System is almost as simple as that. It mixes the boiler water with the return water, and the temperature of the water it sends out to the heating system is varied automatically in accordance with outside temperatures.

The advantages: Simplicity, low cost, close regulation to requirements even in the spring and fall months and a remarkably quick response to weather changes, since the boiler water is always at a higher temperature than that of the water in the heating system.

The Sarcotherm is in satisfactory operation in factories, large apartment projects, small apartments and homes.

Ask for Catalog No. 210.



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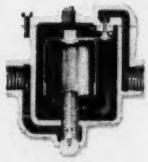

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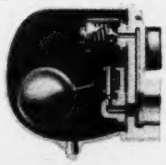

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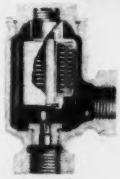

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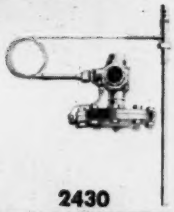


2430

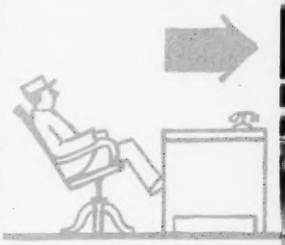
AND IN YOUR BOILER ROOM—

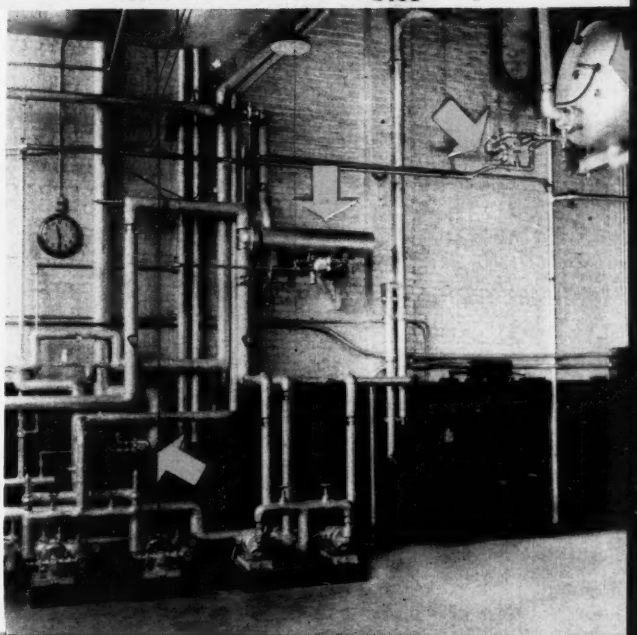
there are a dozen spots where SARCO SAVERS can improve your service and save fuel with an investment that will be forgotten in a few months.

Hot water can be held to exact temperatures giving better service and saving fuel by installing Sarco Temperature Controls and suitable Steam Traps. Oil preheaters properly equipped with traps and control can improve the efficiency of the entire plant. Sarco Strainers will keep the lines free of foreign material, and Sarco Steam Traps as drips on the main lines will keep them free of condensate and, therefore, live and efficient at all times.

Catalogs furnished on request.

. . . here's the Engineer's Dream of Efficiency with SARCO





*THE SARCO FAMILY NOW INCLUDES EQUIPMENT FOR GRAVITY, VAPOR or VACUUM, STEAM and HOT WATER HEATING SYSTEMS and complete service for process heating and cooling operations, including all types of steam traps and temperature control.

Represented in Principal Cities

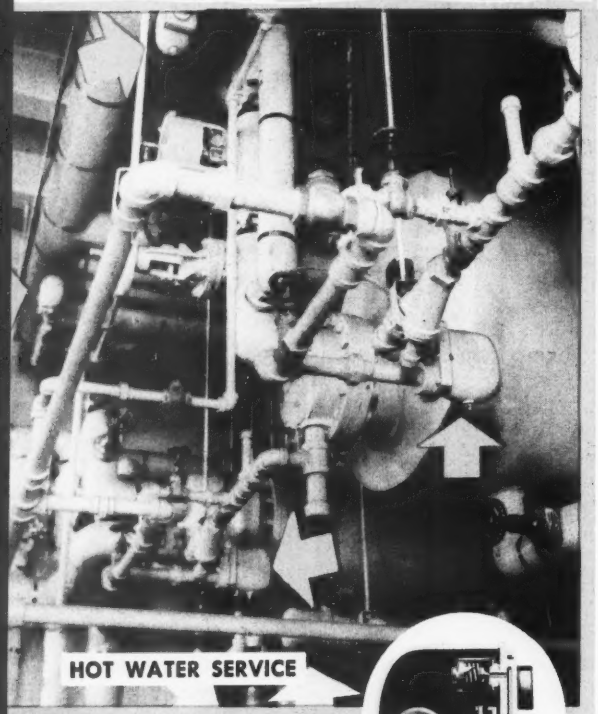
SARCO

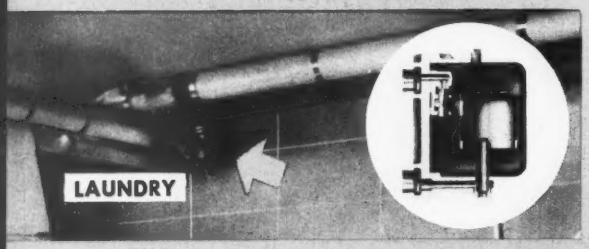
SARCO COMPANY, INC., 183 Madison Ave., NewYork, N. Y. • Sarco Canada Ltd., Federal Bldg., Toronto, Ont.

YOUR NEXT JOB

PROBABLY WILL BE EASY COMPARED TO

THIS ALL-SARCO HOSPITAL JOB





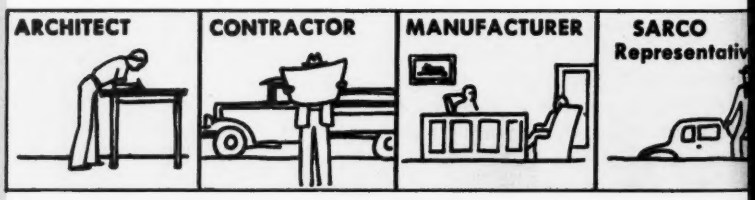
A modern hospital is like a ship—it has everything in it, including the well-known kitchen sink. So, when Sarco Engineers were called in to assist the contractors on this County Tuberculosis Sanatorium, in Northern Illinois, they found plans for a completely modern and highly efficient oil-fired boiler room, hot water services for the kitchens and domestic hot water, and a modern steam laundry added for good measure.

SOLVED WITH SARCO STEAM TRAPS

56 Sarco products are used in this job, and every one has operated satisfactorily from the day it was installed.

Sarco Float-Thermostatic Steam Traps are used on drips, water heaters, heat exchangers, and the fuel oil preheaters. Sarco Inverted Bucket Traps serve the laundry presses and drip the laundry steam line. Sarco Strainers are used to protect each unit in a battery of four water service pumps.

THESE SERVICES ARE READY TO HELP YOU



Don't be confused by the multiplicity of Sarco Products, and the many ways that they can save money and improve the service wherever steam or hot water is used.

Your architect or your heating contractor will know what you mean when you say, "I want ALL-SARCO." If you are buying Steam Equipment, the manufacturer will be glad to put it on at the factory.

You don't have to "insist" on Sarco. Just mention the name in connection with any kind of a job in the heating field. It will be doubly agreeable if you happen to mention it first.

STEAM TRAPS AND CONTROL

SARCO

Represented in Principal Cities

SARCO COMPANY, INC., 183 Madison Ave., NewYork, N. Y.

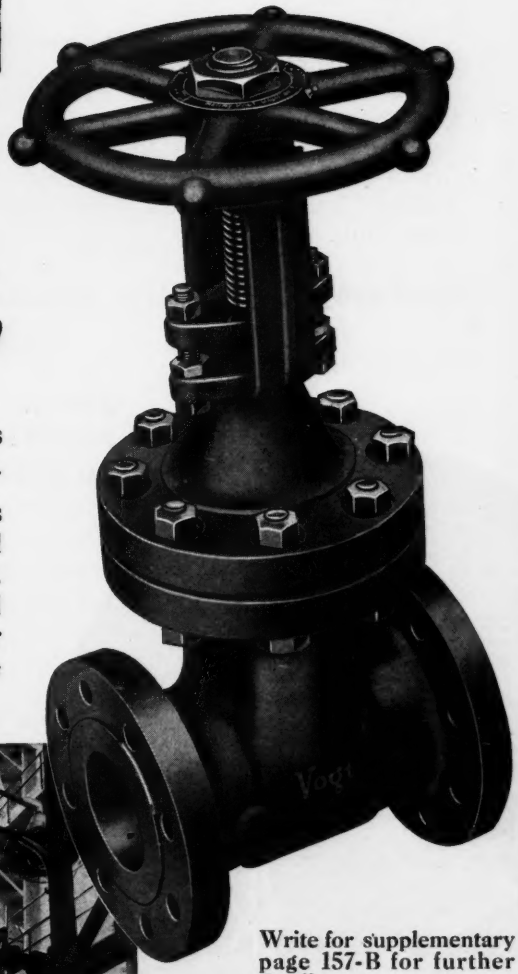
Sarco Canada Ltd., Federal Bldg., Toronto, Ont.

and NOW!

THE 300 POUND LINE

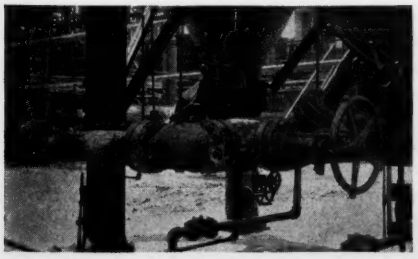
INTEGRAL FLANGED

Drop Forged Steel GATE VALVES by Vogt



Never before has a new line of valves CLICKED so rapidly as our 150 Pound Series.

Now follows the 300 Pound line in sizes from 2" to 8", with flanges forged integral, and complying with the 300 Pound American Standard. Stainless Steel Trimmings are regularly furnished and we recommend them for steam, water, oil or gas service up to 300 pounds working pressure and temperatures to 750 deg. F.



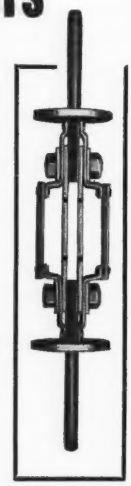
Write for supplementary page 157-B for further details.

HENRY VOGT MACHINE CO., INC., LOUISVILLE, KENTUCKY

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

100% PROTECTION FOR YOUR CIRCUITS

Decide now to do away with the bother and expense of old-style fuses — specify WARE HI-LAG Fuses on all your plant circuits for maximum protection at minimum cost.



These improved WARE HI-LAG Fuses provide an extremely **high time lag** which ends the blow-outs often caused by starting motors and momentary surges.

Then, too, their new **double-bridge** assembly is easier to renew correctly than to overload. Only one end of casing is removed. Assembly may be inserted either end first. Other advantages include Spring Tension Contacts, One Piece Flat Link.

WARE BROTHERS, 4500 Lake St., CHICAGO

N.A.P.E. at Columbus

FOR THE FIRST TIME in a quarter of a century, the N.A.P.E. met at Columbus, O., August 19 to 23 for the 1940 Annual Convention. Strangely enough the meeting was held under world conditions which paralleled those of the earlier meeting in Columbus in 1915, with a large share of the civilized world at war.

Under the circumstances it was but natural that power as an element in national defense occupied the spotlight in the public portion of the program. On Tuesday afternoon, with Past President H. W. Wilds presiding, C. H. McQuigg, Dean of Engineering, Ohio State University, gave an address over the Mutual Broadcasting System on "America's Sources of Power and National Defense." Dean McQuigg said in part:

"Our natural resources of energy and the uses we make of them suggest different ideas to different people, the housewife . . . the farmer . . . the soldier . . . the manufacturer . . . the railroad man. The loss of these multitude services to mankind in a society like ours would be so far-reaching that in such event our civilization could not possibly exist as it is . . .

"Power in a national emergency is vastly more important to the welfare of the nation than it is in peace time. In the first place, we need power in quantities greatly in excess of our peace-time programs because of the urge for manufacturing military material in quantities not conceived of in peace-time . . . This unnatural war load is superposed upon the peace-time requirements of the nation; dislocation of the latter cannot be permitted beyond a certain point, since civilian morale is among the greatest assets of a nation at war. In the second place, disturbances of the power supply are more serious under the conditions of stress attendant upon a national emergency.

"With respect to how much power will be needed in the event of a major emergency, no one knows . . . It is also reasonable to say that any war effort of the nation today—since war has become so highly mechanized—will bring us undreamed of demands for power facilities.

"What can the nation do to meet this situation? In the first place, the Federal Power Commission is charged with the study of this whole question. Decisions will need to be made with respect to the preference for isolated stations over the central generating unit tied into transmission lines extending over large areas of territory. Operating and fuel economies seem to go to a greater extent with the large central stations, particularly where these stations are integrated into huge networks. On the other hand, accident to a single unit supply of larger territories will have graver consequences than the loss of a small individual unit.

"The immediate demand of an emergency will probably be met by the assumption of government control over our fuels and power generation. Suffice

(Continued on Page 122)

Unfinished portrait
OF A VALVE BY JENKINS

You can't figure cost from a price list, when valves last 51 years —as this 2 inch Jenkins Bronze Valve has in the boiler room at Stadler Products, Inc., Cleveland, Ohio.

Tough service, too, says Engineer Louis Fenner (shown above, who has been with the company since 1885) for it controls steam supply at 80 lb. pressure for the reciprocating Feed Pump. And although it's opened and closed four times a day, the only maintenance has been a new disc about every two years.

Here, again, we use the COST-PER-YEAR method, which simply means taking any valve, still in service or about to be replaced, and finding out just how much it cost when installed. Then figure —Initial Cost *plus* maintenance (total cost of any parts that had to be renewed) *divided by* Years of Service *equals* COST-PER-YEAR— the only sound basis of computing valve costs.

JENKINS BROS., 80 White Street, New York, N. Y.; Bridgeport, Conn.; Boston, Mass.; Atlanta, Ga.; Philadelphia, Pa.; Chicago, Ill.; Houston, Texas Montreal, Canada London, Eng.

"COST-PER-YEAR" of this Renewable Disc Valve

Initial Cost	$8.85
+	
Maintenance (*new discs*) . .	$4.50
÷	
Years of Service	51
=	
Cost per Year	$ .26

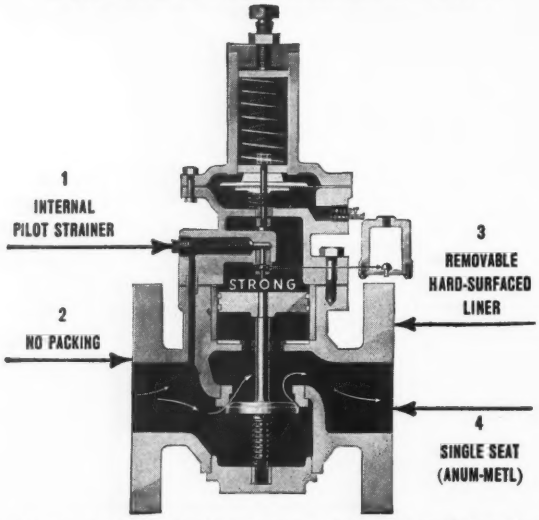
and it's still going strong!

IN VALVES *Jenkins* GIVES YOU EVERYTHING

PIPEWRENCH PETE SAYS:

***Now*—You Can Regulate Pressure to a Gnat's Eyelash!**

4 Trouble-Saving Features In STRONG'S Supersensitive Valve!



How STRONG'S Type "C" Valve Works

High (inlet) pressure forces piston down, opening valve and admitting pressure to reduced (outlet) side. When reduced pressure reaches point valve is set to maintain, diaphragm is forced up, closing pilot valve, and shutting off high pressure to piston chamber. As pressure in piston chamber decreases, bottom spring and steam velocity close main valve.

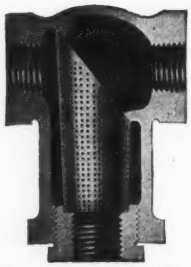
In actual operation, valve automatically adjusts itself to meter the volume of steam, air or gas required to maintain the reduced pressure.

Long, Trouble-Free Life

Because of its simple, sturdy construction, the STRONG Type "C" regulating valve meets the need for accurate, trouble-free pressure regulation.

Write about your pressure reducing problems or for Catalog 154.

QUICK CLEANING STRAINERS



Regular semi-steel, suitable for pressure to 250 lbs. or 400 degrees. Pressure-cleaned by removing bottom plug or opening valve. Install ahead of reducing valves, etc.

The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, O.

STRONG
STEAM SPECIALTIES

10

it to say that such control will likely do at least several things: (1) Establish priority or preference schedules for essential and non-essential uses. (2) Transportation will be co-ordinated and in the last extreme, rationing may be imposed."

At the same session, Capt. A. A. Nicholson discussed "The Value of a Practical Education to the Engineer and his Contribution to Safety in Industry," emphasizing the place of power in the world today and advocating more constructive and creative thinking. In the evening, Dr. Phillips Thomas of Westinghouse demonstrated many results of research, largely experimental today but offering commercial possibilities in the years to come.

At the business sessions, aside from routine matters dealing with committee reports for the past year, much of the time was devoted to a discussion of license law legislation and changes to strengthen the association to more closely meet the needs of the modern engineer with a program suited to the times. Much of this discussion was in the nature of case studies, the experiences of local associations which had been successful or unsuccessful in accomplishing their objectives.

Election of Officers

The orderly progression from vice president to president, which has not been broken since 1905, was disturbed this year by the resignation, on June 5, of National Vice President Alfred Butcher after he had suffered a complete loss of his voice. President Carl R. Daubenmire appointed Otto L. Beiswenger of Ohio '28 to fill the unexpired term. Mr. Beiswenger, who is engineer at the Googyear Tire & Rubber Co., Akron, O., was elected president by unanimous vote on the first ballot.

Stephen C. Casteel of Iowa No. 7 and Chief Engineer of the Davenport Water Co., Davenport, Ia., was elected vice president unanimously on the second ballot after the withdrawal of Theo. E. Rosenberg, California No. 2 from the contest in favor of Mr. Casteel. Fred Raven was reelected secretary also on a unimous ballot.

Geo. M. Diebold, past president and appointed to complete the unexpired term of Treasurer Edwin Burke, forced to retire due to ill health, was reelected in a close contest with Harry Harp of Pennsylvania No. 1 and engineer at the Delaware Jute Mills of Philadelphia. Thomas Herligh, of California and past president, was reelected to the Board of Trustees for a 5 yr. term, in a three cornered contest with Don Kurtz of New Jersey No. 3 and E. C. Chapman of Missouri No. 2. Evan Dillon, West Virginia No. 3 was unanimously elected conductor on the first ballot. John Summers of Texas No. 2 was elected doorkeeper.

The selection of the next convention city was hotly contested, with New York, Baltimore, Kansas City, New Orleans and Boston in the race. It was finally won by Baltimore on the second ballot after Kansas City and New Orleans withdrew in favor of the final winner. Baltimore received 98 votes against 92 for New York on the first ballot and ran this up to 144 against 84 on the second ballot.

Extra CONVENIENCES

Have your present iron-body wedge gate valves ***ALL*** *of these conveniences?*

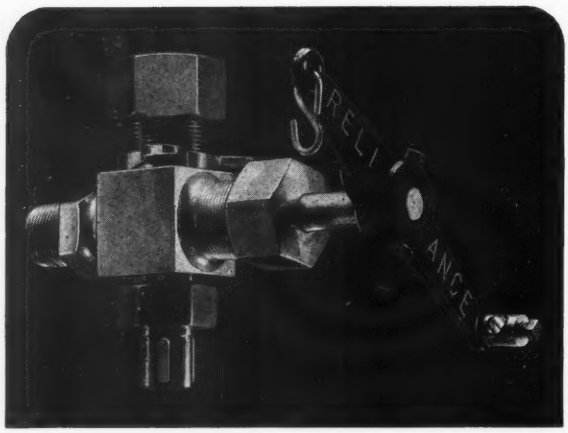
Convenience Feature	Kennedy Standard Wedge Gate Valves	Your Present Valves
Large diameter five-spoke handwheel with ample room for firm grip for operator's hand.	YES	
Oil hole in yoke cap for easy lubrication of yoke-nut bearing surfaces.	YES	
All bolts with nuts on top for easier manipulation. Open-end wrench can be used on all bolts.	YES	
Bonnet shelves to hold gland out of the way while repacking.	YES	
Washer-type nuts on stuffing box bolts—no separate washers to get lost.	YES	
Hinged eye-bolts at stuffing box gland drop out of the way but cannot fall out while repacking.	YES	
Rust-proofed stuffing-box bolts and nuts to prevent rusting together.	YES	
Lugs on pipe ends of screwed valves for chain or pipe wrench.	YES	

These Kennedy Iron-Body Wedge Gate Valves, which set a new standard of quality and service at standard market prices, are described in detail in Bulletin 50 which will be sent on request. Write for your copy.

Extra convenience is but one of the many extra values in Kennedy Valves. In quality of metal, special features of design, accuracy of machine work, and finish of all parts, too, Kennedy Valves give you extra values at no extra cost. You are always safe when you use Kennedy Valves.

The Kennedy Valve Mfg. Co. -- Elmira, N. Y.

KENNEDY
VALVES with Extra Value

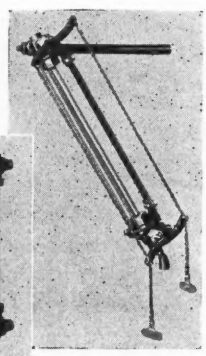


How to Prevent Costly Water Gage Failure *with RELIANCE Gage Valves*

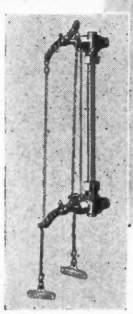
"Steam-proof" and "leak-tight"—that's the kind of protection you get in Reliance Gage Valves. They guard against leaks and sputtering and fizzing on your water columns. And you don't have to "shell out" for frequent repairs and replacements • Reliance Valves have a substantial way of winning your admiration. They're quick-closing—chain operated. Bodies of tough bronze, polished; monel discs, bronze seats. Extra heavy to withstand 450 lbs., 550° F. easily. Complete line includes valves for lower pressures • It's important and valuable to have worry-free valves that save expense and annoyance as thousands of plants, large and small, have proved with Reliance Valves.

Write today for new Bulletin 401.

The Reliance Gauge Column Co.
5902 Carnegie Ave • Cleveland, Ohio



• Reliance Tiltview (pat'd) Water Gage, for easier visibility where gages are high above the floor.



• Reliance Water Gage for vertical use. Also available with flanged connections.

Reliance
Boiler Safety Devices since 1884

Coal Price Regulation

THE Bituminous Coal Division of the U. S. Department of the Interior has issued marketing rules and regulations covering the sale at the mine of bituminous coal under established minimum prices. These are designed to prevent possible evasion of minimum prices and better to enable the Division to enforce provisions of the Coal Act prohibiting certain trade practices which Congress found unfair.

Minimum prices and marketing rules are to become effective on October 1, 1940. They are subject to appeals to the Secretary of the Interior and cover the sale at the mine of substantially all of the coal produced in the United States. They are established under the Coal Act as a means of stabilizing coal markets by eliminating price cutting and certain trade practices and by maintaining a "cost floor" under prices at the mine.

The marketing rules prohibit producer Code Members from evading minimum prices in marketing their coal through sales agents, representatives, and distributors.

Producer Code Members and all of their agents, representatives or distributors may not sell coal at less than the minimum prices comprising the "cost floor" without incurring penalties provided by the Coal Act. They may sell at prices higher than the minimums, however.

The rules prohibit evasions of the minimum prices through such practices as substituting better grades of coal than that ostensibly ordered and paid for by a purchaser. Subject to approval by the Division, however, bona fide substitutions may be made by producers to meet temporary emergency situations.

When chemical analyses, showing the quality of coals, are utilized by Code Members, sales agents or distributors, in selling or offering for sale any coal produced by a Code Member, a report of these analyses must be filed with the Division and the District Bituminous Coal Producers Board. These reports will be subject to inspection at Division's office, in Washington, and may be used by the District Boards in proposing future minimum prices for the coals of producers filing them.

This, Division Marketing officials said, will act as a safeguard against possible misrepresentation of the quality of a coal to a purchaser.

The marketing rules and regulations provide that contracts for the sale of coal must contain certain provisions which are designed to prevent evasions of minimum prices. Producers must charge the minimum price in effect at the time the coal is delivered.

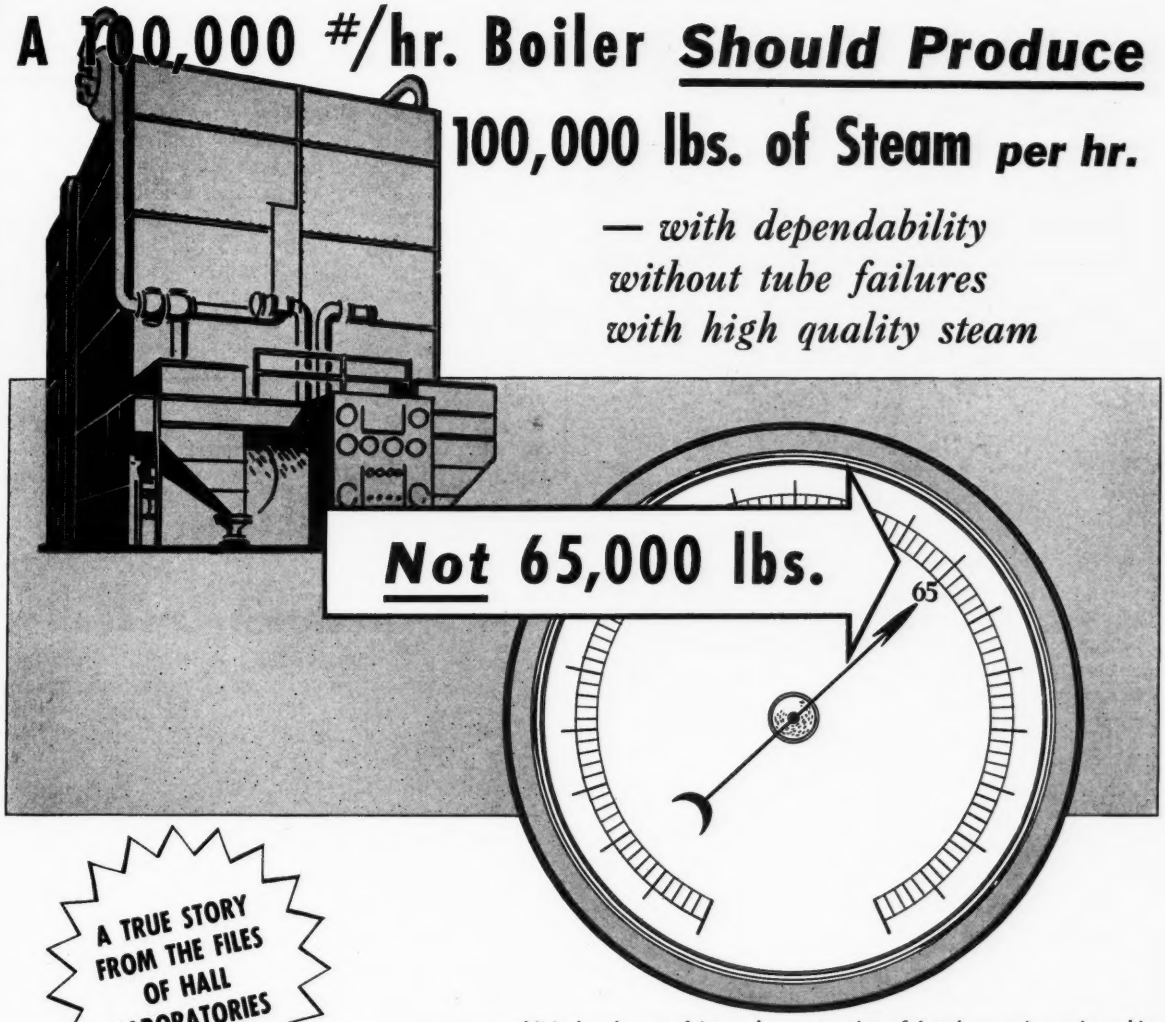
Although the marketing rules limit agreements for the sale of coal generally to 30 days, subject to further order of the Division, they provide that contracts for periods not exceeding one year may be made with agencies of the Federal or local governments. The rules also provide that contracts exceeding the 30-day limit may be made upon special permission or approval of the Division upon a showing of the necessity of meeting long-term competition of oil, gas, or other forms of fuel and energy, or for such other reasons

(Continued on Page 126)

A 100,000 #/hr. Boiler ***Should Produce***

100,000 lbs. of Steam *per hr.*

— with dependability
without tube failures
with high quality steam



A TRUE STORY FROM THE FILES OF HALL LABORATORIES

A NEW boiler, rated at 100,000 #/hr., had been installed in a Southern industrial plant. Because of severe carry-over, the load had been limited to 65,000 #/hr. Mechanical changes in the baffling arrangement in the steam drum had proved futile. It was necessary to find a different remedy.

Hall Laboratories were called in, and after carefully analyzing conditions in every phase of the water-steam cycle, they arrived at these conclusions:

1. *The softener was operating satisfactorily, but the high silica content of the water made necessary very careful control of treatment conditions in the boiler water to avoid silica deposition.*
2. *Organic contamination in the condensate returns must be eliminated to secure steam uncontaminated by carry-over with the boiler operating at its full capacity.*

The necessary exact control on the boiler water was established, and most of the work done to eliminate contamination from condensate returns. But . . . at this stage, the plant engineers were prevailed upon to discontinue Hall Laboratories' control as unnecessarily thoroughgoing, and to substitute instead a particular compound, which was supposed both to eliminate carry-over, and, by combining with silica, to prevent scale formation.

Within sixty days, thirty-six tubes were lost in the boiler because of calcium-silicate scale.

Hall engineers were recalled to establish the Hall methods of control. With the cooperation of the plant engineers in making the necessary changes to avoid severe contamination of the condensate, this boiler was soon performing satisfactorily. It has operated continuously since then with a high degree of efficiency, producing 100,000 pounds of steam per hour, even more at times, under complete Hall System with Hagan Phosphate conditioning — and with no appreciable carry-over taking place.

This is one of the many cases where Hall System of Boiler Water Conditioning has made great improvement in plant efficiency. Seventeen other cases covering a wide variety of boiler troubles are described in our new booklet. Send for a copy today.

Hall Laboratories, 300 Ross St., Pittsburgh, Pa.

Gentlemen: Please send a copy of your new booklet, "17 Case Histories from the Files of Hall Laboratories."

Name.....

Company.....

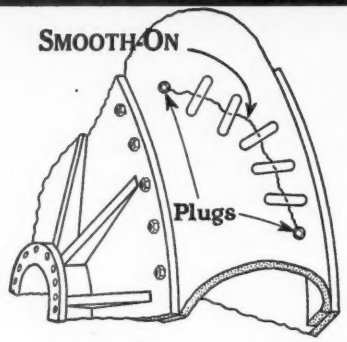
Address.....

City..... *State*.....

SEND FOR NEW BOOKLET

HALL SYSTEM *of Boiler Water Conditioning*

CRACKS
lastingly sealed
with SMOOTH-ON No. 1



Smooth-On No. 1 tamped into a crack expands in hardening and forms a permanently pressure-tight seal. The repair is quickly made without heat or special tools, and requires no previous experience.

With a can of Smooth-On No. 1, you will be prepared to stop leaks in boilers, tanks, heaters, pump shells, pipe lines, etc., make joints and seams tight, and tighten loose bolts, rivets, fixtures and equipment parts.

Buy Smooth-On in 7-oz., 1-lb., 5-lb. cans or 25-lb., 100-lb. kegs from your supply house or if necessary, from us. For your protection, insist on Smooth-On—used by engineers since 1895.

FREE
REPAIR HANDBOOK

Dozens of time-saving, labor-saving and money-saving applications of this many-purpose repair cement are described in the 40-page Smooth-On Handbook, which contains 170 diagrams showing ingenious, practical repairs to equipment all over the plant. To receive your free copy, fill in and mail the coupon.

SMOOTH-ON CEMENTS

for the Motor Car and Boat, Home, Factory and Power Plant

SMOOTH-ON MFG. CO., Dept. 31.
570 Communipaw Ave., Jersey City, N. J.
Please send SMOOTH-ON HANDBOOK.

Name .....

Address .....

9-40 .....

Do it with SMOOTH-ON

as the Division may deem appropriate in order to further the effectual administration of the Coal Act.

Only one discount may be allowed by a Code Member producer on a single sale under the marketing rules. Discounts or allowances from the minimum prices, within maximum limits set by the Division, may be allowed only to persons authorized by the Division to receive them. The Division already has established, subject to appeal by the Secretary of the Interior, the maximum discounts which may be allowed, and has provided machinery for registering persons eligible to receive them and issued regulations requiring such persons to observe minimum prices, marketing rules and other promulgations and determinations of the Division affecting them.

The marketing rules provide against evasion of minimum prices or the discrimination between coal purchasers through the terms of payment, and claims for adjustments because of alleged shipment of substandard coal.

Progress In Accident Prevention

ACCIDENT rates in the public utility industries has, during the past thirteen years, made definite progress in the right direction. This progress, however, seems to have reached a level in about 1932 since which time both the frequency and the severity have been maintained almost constant, so far as the electric utilities are concerned, according to recent reports from the National Safety Council.

In making its reports, the Council defines the injury frequency rate as the number of reportable injuries per 1,000,000 man-hours of exposure, and the injury severity rate as the number of days lost as the result of reportable injuries, per 1000 man-hours of exposure. This rate includes arbitrary changes for permanent disabilities and deaths, in accordance with the standard scale. Some of the outstanding facts about the 1939 experiences in the utilities are as follows:

All types of public utilities averaged 11.55 for frequency and 1.57 for severity during 1939. While the frequency rate was slightly below the average of 11.83 for all industries, the severity rate was higher than the general average of 1.42.

Large utilities had better records than did small companies, averaging 10.54 for frequency and 1.44 for severity.

Progress in reducing injury rates since 1926 has amounted to 78 per cent for frequency and 72 per cent for severity. These reductions easily exceed average decreases of 69 per cent and 50 per cent in corresponding rates for industry as a whole.

Small companies, on the whole, had the best results in comparison with 1938, reducing frequency four per cent and severity 18 per cent.

Only gas and electric and straight electric companies made reductions in both injury rates from 1938 to 1939.

The outstanding feature in the experience of public utilities with different types of injuries during the past 13 yr. has been the large reduction in the frequency of fatalities, 71 per cent.

(Continued on Page 128)

It's a Fact . . . Why?

THE LARGEST SELLING UNAFLOW ENGINE IN THE UNITED STATES IS THE SKINNER "UNIVERSAL UNAFLOW"

The "Universal Unaflow" was the first poppet-valve unaflow steam engine to be built in this country. Its advent revolutionized the steam engine industry to such an extent that ten other engine builders brought out types of unaflow engines which did not infringe the many patented features of the "Universal Unaflow" engine with its originality of design. Reliable statistics show that 50% of all the unaflow engines built in this country have been "Universal Unaflow" engines. We believe the annual sale of "Universal Unaflow" engines today amounts to a far greater percentage.

It can be proved that this is the only poppet-valve unaflow engine built in this country with valves which are permanently steam-tight. Many contracts have been made with provision for acceptance tests after a year's operation to demonstrate the fulfillment of the original guarantees.

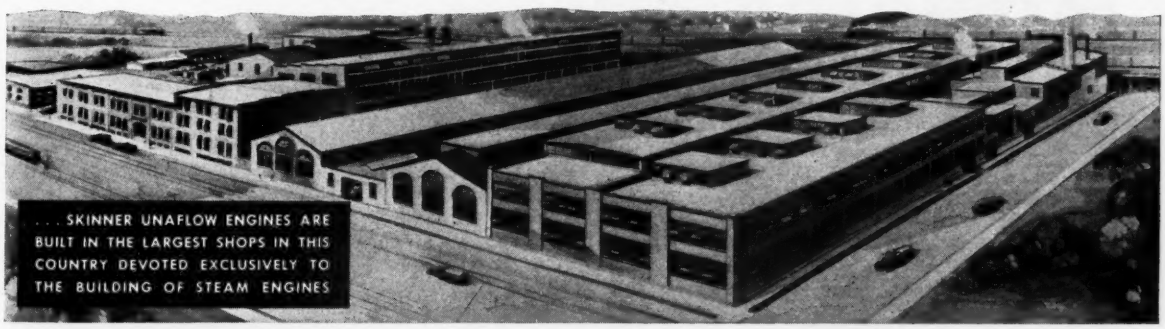
The engine is aptly named "Universal Unaflow." It can be operated condensing, or noncondensing with constant or variable back pressures. Its applications include drives for constant-speed generators, as well as constant-speed and automatic or manual variable-speed drives for compressors, blowers, or pumps.

"Universal Unaflow" engines are built in single-cylinder horizontal and multi-cylinder vertical types. Many of these vertical engines are now being installed for marine propulsion, as well as for centrifugal dredge-pump drive.

Owners' satisfaction with the "Universal Unaflow" engine is best shown by the fact that we have received 402 Repeat Orders, 133 of which came from purchasers who had previously installed other makes of unaflow engines.

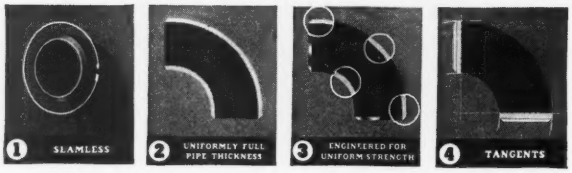
The "Universal Unaflow" is "the most economical steam engine built," and this superiority has been made possible through our continuous program of research and testing. Unquestionably, it is the most thoroughly tested steam engine. Altogether 2014 economy tests have been conducted on "Universal Unaflow" engines, consisting of 1604 in the factory and 410 in the field.

SKINNER ENGINE COMPANY, ERIE, PA.



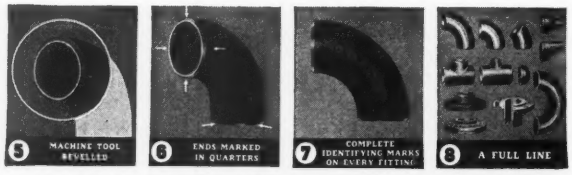
. . . SKINNER UNAFLOW ENGINES ARE BUILT IN THE LARGEST SHOPS IN THIS COUNTRY DEVOTED EXCLUSIVELY TO THE BUILDING OF STEAM ENGINES

TAYLOR FORGE



On your next job

make the acquaintance of the only welding fittings that offer you all these 8 aids to faster, easier welding.



WeldELLS

Seamless Pipe Fittings for Welding

TAYLOR FORGE & PIPE WORKS

General Offices and Works: Chicago, P. O. Box 485

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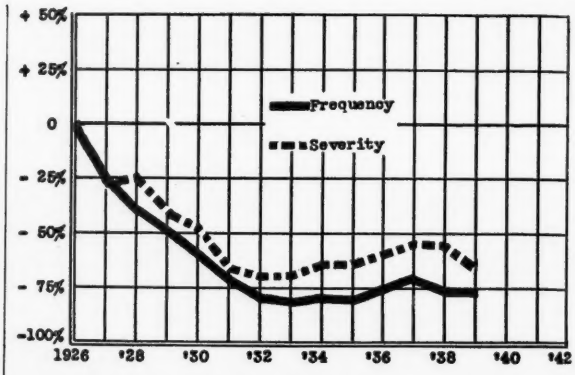
Philadelphia Office: Broad Street Station Bldg.



Changes in Accident Rate in Electric Utilities

The outstanding unsafe act involved in 309 serious injuries, principally fatalities, was assuming unsafe position, such as entering areas unsafe due to electrical and gas hazards, standing under suspended loads, riding on trucks in an unsafe position, and working on high tension conductors from above instead of below.

The principal mechanical cause of fatalities and permanent partial disabilities was improper guarding and the principal personal cause was improper attitude, such as disobedience of instructions and abstraction.

The Fall River Electric Light Co., Fall River, Mass., has established a new all-time no-injury record—4,337,640 man-hours. The record began June 18, 1930, and was unbroken on January 9, 1940.

Illinois Institute of Technology Elects Officers

FINAL action on July 24 heralded the creation of Illinois Institute of Technology through the merger of Armour Institute of Technology and Lewis Institute. The action, in the form of the first meeting of the Board of Trustees of the new institution and the election of officers, came almost ten months to the day from the time that consolidation plans for the two institutions were first announced.

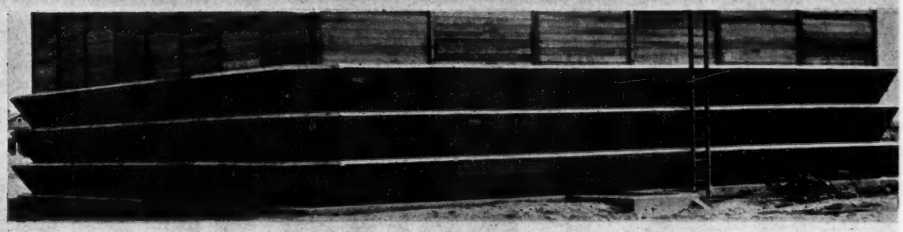
Henry T. Heald, for two years president of Armour Institute of Technology, was elected President of the new institution. Mr. Heald becomes the first president of the new school and at the same time becomes, at the age of 35 yr., the youngest president of so large an educational institution.

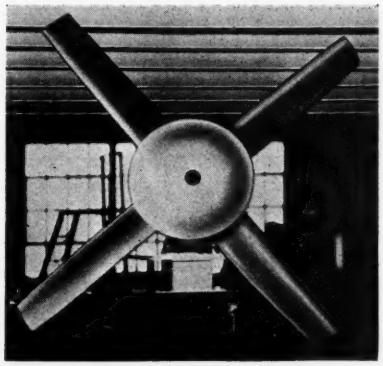
Preliminary action, paving the way for completion of the merger, was taken when the separate Boards of Trustees of Armour Institute of Technology and Lewis Institute met to adopt consolidation resolutions in accord with the decree of Judge Robert J. Dunne, permitting Lewis Institute to enter into the merger. Articles of Incorporation for the new institution have been filed in Springfield, and the election of officers was announced by the joint Board of Trustees, which numbers approximately 60 prominent business men and industrialists.

James D. Cunningham, who for 7 yr. was chairman of the Board of Trustees of Armour Institute of Technology, was elected chairman of the Board of the

(Continued on Page 130)

OPERATING COSTS REDUCED ~ in NEW PRITCHARD INDUCED DRAFT TOWER





WITH LOW HEAD • LOW AIR VELOCITY AND NON-CORROSIVE FANS APPROXIMATELY ½ THE WEIGHT OF CAST ALLOY

Pritchard engineers took time to design a better induced draft tower—a tower that combines highest cooling efficiency with unusual operating economy. This tower is substantially constructed in every way. It operates under low pumping head. Air is drawn into and through the tower at low velocity to reduce horsepower requirements. Pritchard fans, on which basic patents are pending, are made of non-corrosive monel and are approximately 50% lighter than any other type now in use.

These fans are of stressed skin design with wide, adjustable pitch, airfoil section blades bolted to a reinforced monel hub. Their scientific design and light weight result in higher efficiency, low power requirements, longer speed reducer life.

These fans also are available with Pritchard forced draft towers. Write for complete details.

J. F. PRITCHARD & CO.

DWIGHT BUILDING — KANSAS CITY, MO.

Branch offices in Tulsa, Okla.; Houston, Texas; Chicago, Ill.; Columbus, Ohio, and St. Louis, Mo.

PRITCHARD

Atmospheric and Mechanical Draft

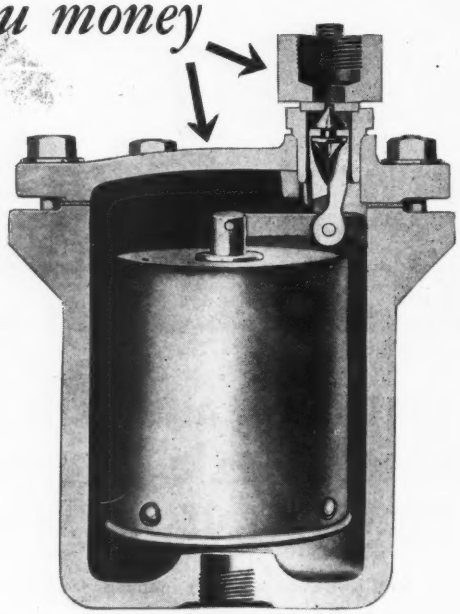
WATER COOLING TOWERS

K-MASTER

(Inverted)

STEAM TRAP

features that will save you money



One of the 150 K-Master Steam Traps installed in a prominent food processing plant in eastern Massachusetts.

NOTE: the External Valve Assembly, so located as to be readily inspected without either removing the cover or taking the trap from the line.

NOTE: the Reversible Valve and Seat, giving in effect double life to this replaceable part of the trap. These are of stainless steel for long life and so designed as to permit uniform heat treatment.

NOTE: the Self-Tightening Joints, resulting from the use of bronze valve body and steel studs. Differential expansion on all parts plus ground joints provide absolute self-tightening joints.

Other features include positive, decisive snap action; free and non-binding action; self-centering valve; outside disclosure of internal leaks; self-cleaning vent; facilities for rapid venting of excess air or gas; rugged construction. Why not try out this K-Master Trap as so many others have done? Send for our catalogue from which to make a selection.

KAYE & MACDONALD, Inc.

92 Franklin Avenue **West Orange, N. J.**

new institution. Alex D. Bailey, for many years the chairman of the Board of Lewis Institute, was elected vice-chairman of the new Board.

The merger of Armour Institute of Technology and Lewis Institute signals the completion of two years of effort of the respective Boards. The backgrounds and reputations of the two component colleges are to be recognized in the new institution by use of the names Armour College of Engineering of Illinois Institute of Technology, for the Division of Engineering, and Lewis Institute of Arts and Sciences of Illinois Institute of Technology, for the Division of Arts and Sciences. The third division of the new Institute will be the Armour Research Foundation, which has been in existence since September, 1936. The Research Foundation will continue to render a professional research and experimental engineering service to industry.

For the coming academic year, 1940-41, an attempt will be made to coordinate courses although there is to be no shakeup of the two faculties. It is expected that the full-time instructors of both institutions will number over 200.

Nickel in the Electrical Field

PRECISE photographic exposure meters, speedometers, electrical, torque and flow meters, as well as wattmeters and other electrical instruments now employ Alnico permanent magnets. These nickel alloy magnets are also entering into larger electrical equipment including blowouts and magnetic latches for contactors, motors which will "back off" when overloaded, and in numerous small devices.

In contrast are the magnetically soft nickel-iron alloys used for the cores of high quality audio frequency transformers, loading coils for long distance telephony, magnetic shields, and for accurate current transformers.

Motor slip rings made of copper hardened with a few percent of nickel have found considerable use in England, while monel has proved very suitable for slip rings in devices which operate infrequently, and which must not corrode or develop high resistance while idle.

Fluorescent tube lights show promise of revolutionizing the lighting industry. Nickel electrodes are widely used in these lamps as well as in signs, and are now being produced at low cost by highly specialized equipment.

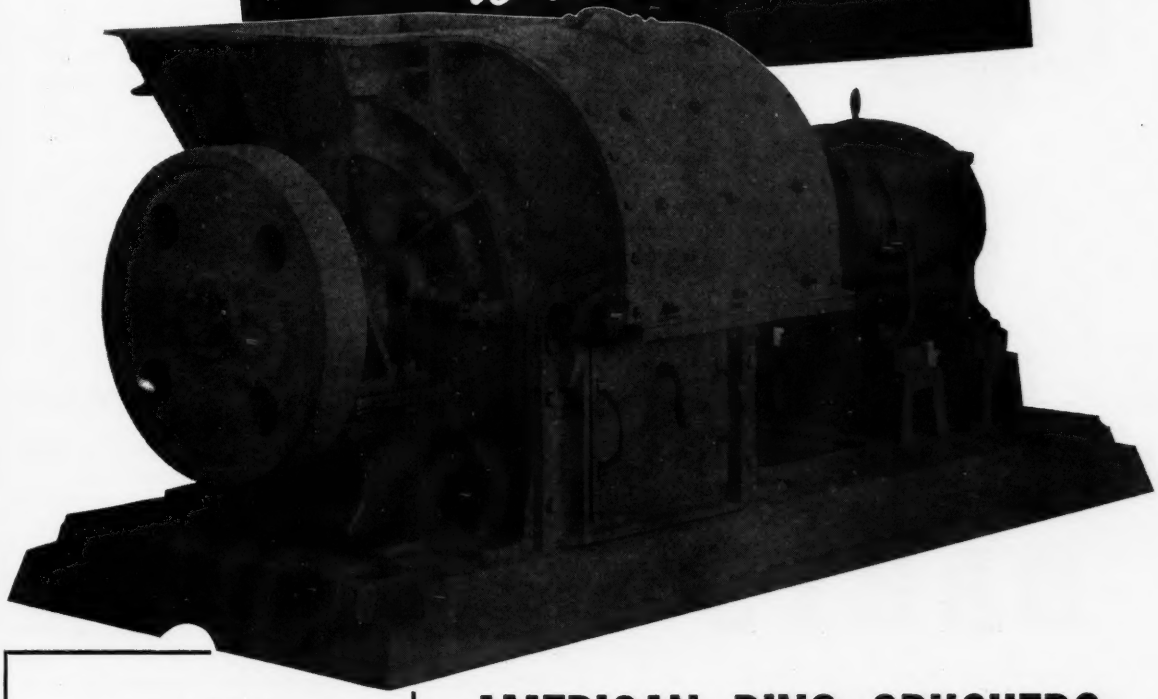
Nickel alloys are standard in automobile spark plugs while monel is preferred for high tension distributor parts which must withstand arcing and corrosion. Numerous operating and contact springs are made of monel, "K" monel and the new heat treatable nickel alloy, "Z" nickel.

During the year two new developments in nickel-iron-alkaline storage batteries were announced in the United States.

One was the development of an improved model of electric cap lamp which affords increased illu-

(Continued on Page 132)

Memo to men who want to trim fuel costs



IMPORTANT TYPE "S" FEATURES

This improved "AMERICAN" Ring Crusher pictured above is unbreakable from any crushing strain—anti-friction bearings—patented adjustable grinding plate—tramp metal passed without injury.

PATENTED SHREDDER RING SPLITS COAL

The improved Shredder Ring developed by "AMERICAN" designing engineers (see below) makes it possible to size coal properly for either stoker or pulverizer fuel firing by making a simple adjustment. Through the use of a reversible manganese Shredder Ring, coal is actually SPLIT rather than crushed.

AMERICAN RING CRUSHERS can save up to 8%!

Scores of industrial plants, central stations and service institutions have started their boiler room economy programs with AMERICAN Ring Crushers.

These plants report that the improved operating efficiency — due to better coal sizing with "AMERICANS"—have reduced total fuel costs from 2½ to 8%, on either pulverized or stoker coal burning.

You, too, can size coal for savings the "AMERICAN" way. Our engineers will gladly place you in touch with "AMERICAN" equipped plants where you will be given every opportunity to check the actual savings being effected.

AMERICAN PULVERIZER COMPANY 1429 Macklind Avenue St Louis, Missouri

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

BETTER USE
DARTS
in the First Place

When a leak in a fitting calls for repairs, chances are that a Dart Union would have saved time and trouble. Because Darts have *all the qualities* that assure permanent tightness: two bronze seats ground to a spherically accurate fit, plenty of "heft" in the bodies and nuts.

More than that, Darts have earned a reputation for repeated service. Take down a Dart and reinstall it. Again and again, you'll get honest, dependable service. Use Darts *in the first place,* and save.

DART
UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.
Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

mination and lighter weight. Electric cap lamps are rapidly replacing open flame lamps in both coal and metal mines.

A second development consists of a type of cell which affords approximately one-third more power and capacity in proportion to the horizontal dimensions than previously available in nickel-iron-alkaline batteries. The new cell meets a demand for batteries for use where horizontal space is at premium, such as heavy-duty industrial trucks, trucks operating 24 hr. daily or trucks used for carloading and restricted to narrow clearances and short turns.

The general outlook for heavy-duty industrial storage batteries continued favorable. Air conditioning of steam railroad passenger cars continues to result in the application of larger batteries. Industrial trucks now going into service average much larger batteries than formerly. Popularity of Diesel power in new marine construction is resulting in larger marine electrical systems and correspondingly larger batteries.

Stevens Management Conference

FOR THE PAST 10 yr. Stevens Institute of Technology has conducted an eight-day conference for the pooling of experiences in current developments in management. These have been held at Johnsonburg, N. J., and this year this date was June 22 to 30, inclusive. This conference was attended by over a hundred business and industrial executives, engineers and professors of management engineering, and was addressed by men with outstanding reputations in their specialized fields of management. During the course of this conference many statements of sound business and human relations policies were offered for the consideration of management engineers and from among these the following statements are quoted:

Profit Motive Stressed

The first consideration of the industrial executive, is the making of profits for his company. Every decision that is made, every policy that is set up must be viewed in the light of how it may or may not affect the profit making ability of the corporation. Unless there are profits no corporation can long continue in business. Therefore a large fraction of the Chief Executive's problems lie on the financial side, and his relations with the financial officer of the company are extremely close.

The operation of the budget is something to which the Chief Executive must give continuous and close attention. He must be sure at all times that there will be sufficient cash balance to meet payrolls, taxes and material bills as they come due. If possible, this cash balance should be derived at all times from the revenue from sales. Therefore, it is highly important in setting up the budget that it should be set up to represent the cash flow over short periods, say, by the month. This will be determined by the sales forecasts turned in by the Sales Manager showing the volume of sales by products and by periods which

(Continued on Page 134)

BADGER EXPANSION JOINTS

WHY THEY'RE THE BEST BUY

PACKLESS

HEAT-TREATED

DIRECTED FLEXING

STAINLESS STEEL *as well as* SPECIAL COPPER

CLOSE TRAVERSE SELECTIVITY

EXPERIENCED

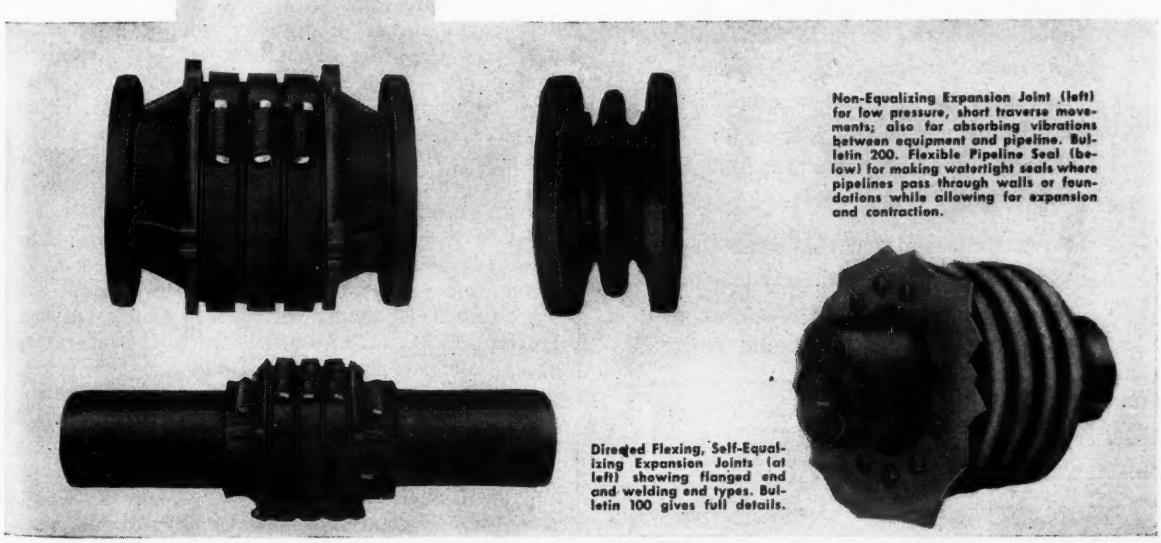
Install 'Em and Forget 'Em!

PACKLESS ... all Badger Expansion Joints are of the corrugated, packless type. This means they require no packing, hence no maintenance throughout their long life. Why pass up this money-saving feature even if your requirements call for only one, two, or a dozen expansion joints? You save just as much on each joint, proportionately, as one of the biggest utilities in the country which already has over 3,000 Badger Joints in its lines. This packless feature alone makes the Badger Expansion Joint a good buy. Other features are "plus" values. All are discussed in bulletins which will be sent on request.

E. B. BADGER & SONS CO.

75 Pitts St., Boston, Mass.

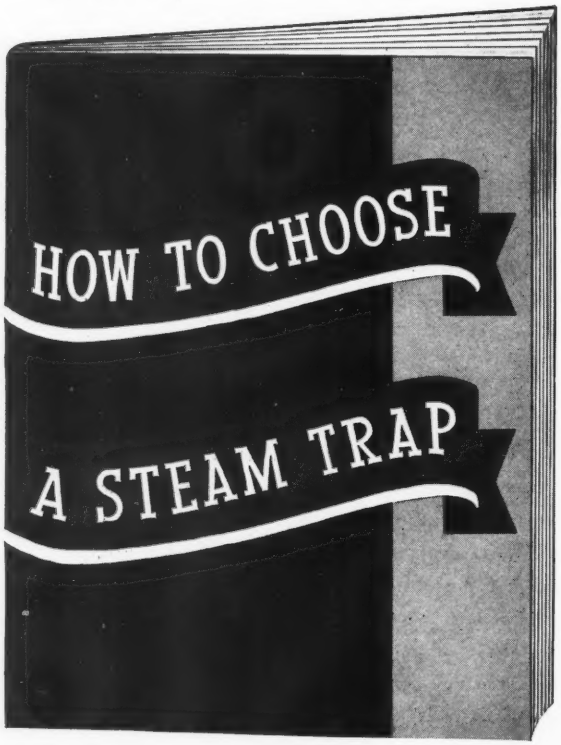
Agents in Principal Cities



Non-Equalizing Expansion Joint (left) for low pressure, short traverse movements; also for absorbing vibrations between equipment and pipeline. Bulletin 200. Flexible Pipeline Seal (below) for making watertight seals where pipelines pass through walls or foundations while allowing for expansion and contraction.

Directed Flexing, Self-Equalizing Expansion Joints (at left) showing flanged end and welding end types. Bulletin 100 gives full details.

SIMPLE FORMULAS
DIRECT READING CHARTS
HELPFUL GRAPHS AND TABLES



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"How To Choose A Steam Trap" is a convenient, informative book. Condensation rate charts, graphs and tables—short formulas for computing condensing capacity of steam using equipment—trap sizes for unit heaters, autoclaves, header drips, jacketed kettles, etc., all this and more is included in this helpful, new steam drainage guide.

Save time and trouble—don't deny yourself the aid of this handy volume—send the coupon today for your free copy of "How To Choose A Steam Trap."

THE V. D. ANDERSON CO., *1939 West 96th Street, Cleveland, Ohio*
I would like a copy of the book "How To Choose a Steam Trap," and I understand that this does not obligate me in any way.

Name..... Company.....
Title..... Address.....
City..... State.....

can be translated into dollars of revenue within the ensuing 30 or 60 days. Against this volume of sales must be set up the volume of expenditure necessary for labor and materials to produce the goods that are sold. These expenditures will precede the corresponding cash inflow by some 3 to 4 months and it is the period between that should cause concern. It is easily possible with good sales forecasting to so set up the budget that the Comptroller can predict with almost uncanny accuracy what his cash inflow will be during any particular month. Alongside of this he can also show with almost the same accuracy what his expenses will be for operating the organization. With these facts before him, the amount of financing, if any, will be quite evident. The Chief Executive's job then is to rearrange schedules, if possible, so that financing is unnecessary.—Robert T. Kent.

Function of Industrial Research

Industrial research activities in this country have increased nearly four-fold within the past 18 yr., according to information that has been assembled by the National Research Council. Some 2000 companies now maintain research laboratories; about 50,000 scientists and engineers are engaged in technological investigations, and more than $200,000,000 is being spent annually in support of their work. The benefits from this remarkable growth in scientific research are reflected in the many new and improved products that have been introduced into daily use.

The most striking tool of modern chemistry is the operation known as synthesis. This term designates the preparation or production of a chemical substance by changing its internal structure. The procedure has been applied most extensively in the field of organic chemistry and it is the basis of some of our most progressive industries. The evidence of accomplishment is found in such outstanding examples of "molecules-made-to-order" as artificial fibers, synthetic resins, and synthetic rubber. The infusion of synthetic methods into a number of older branches of manufacture, such as petroleum refining, has exerted a profound effect.

When the chemist is searching for a new material for an industrial use he usually tries first to synthesize a molecule identical with or similar to some naturally occuring product or roughly the desired properties. In order to obtain a still better result it is often possible for him to design a molecule to meet the specifiic needs he has in mind. This sort of research is being carried on in many laboratories throughout the country. The translation of these complicated processes from a test tube scale to commercial manufacture is the field of the chemical engineer.

It is extremely difficult to estimate the actual value of an industrial research project in terms of dollars and cents. Nor is it feasible to designate an exact fraction of the financial return from a research project which should be attributed to the laboratory group. Commercial success of the new product or process is the result of the joint efforts of the research men who laid the foundation for its technology, of the development engineers who made it feasible on a practical scale, of the production and sales groups, and particularly of the management who have supported it through all these stages.—Lawrence W. Bass.

5 big features *make this* Industrial Advertising Conference *a "must" for you!*

"CLINICS" . . . informal group discussions of "Tying in Advertising with Selling," "Getting Salesmen's Cooperation," "Direct Mail," "Measuring Results," "Market Information," "Copy Testing," "Programs that Management Will Approve," "Layout, Copy and Illustration," "Allocation of Budgets" and other problems. *Inside information on successful methods and campaigns,* and an opportunity to have *your questions answered.*

ADVERTISING DISPLAY . . . direct mail, publication ads, sales literature and company magazines that are being used by hundreds of large and small industrial advertisers. Awards for outstanding work. *Stimulating source of new ideas.*

GENERAL SESSIONS . . . led by national authorities, on current industrial advertising and sales developments. Enable you to *keep abreast of trends that affect your business.*

RELAXATION . . . annual banquet, show, and dance . . . publishers' reception . . . opportunity to visit friends . . . program for wives, including trip through Ford's Greenfield Village.

CUSTOMER CONTACTS . . . you can visit important customers in Detroit plants, see your company's products being used, get first-hand reactions to advertising, take photographs for use in your 1941 advertising and sales promotion.

GOING TO BUY A NEW CAR? — You can save money by taking delivery in Detroit and driving it home.

Markets and selling conditions are changing. But profitable sales await those alert companies who study the trends and improve their practices. At this Conference you will get new ideas that will help you do a better, more efficient job, and make your 1941 advertising and sales promotion program more effective.

All Industrial Advertising and Sales Executives Are Invited

If your company sells to other business organizations, rather than to the general public . . . you will find this Conference devoted 100% to ***your*** problems. You are invited to attend, whether or not you are a member of N. I. A. A.

Write now for program and advance registration form, to Mr. Henry Doering, Registration Chairman, Truscon Laboratories, Inc.; Box 69, Milwaukee Junction P. O., Detroit, Mich.

Advance Registration Saves You Time and Trouble

No waiting to register . . . your Conference and hotel registrations will be made in advance . . . card, badge, program and room key ready when you arrive—pay $10 Conference fee and go directly to your room or to first meeting.

18th Annual CONFERENCE *and Exposition*
National INDUSTRIAL ADVERTISERS *Association*
SEPT. 18, 19, 20 . . . DETROIT . . . HOTEL STATLER

For the Engineer's Library

Recent bulletins and catalogs on power plant equipment listed for your convenience in securing specific information. Power Plant Engineering will be glad to procure for you any free literature that you desire.

Controls, Meters and Instruments

1—Regulators—A new 16-pp. catalog No. 52 covers self-operated temperature regulators for controlling flow of steam, gas, water, or brine. A special feature is complete capacity tables for several different valve styles to meet control problems in connection with industrial process work, water heating, air conditioning, refrigeration, etc. Sarco Co., Inc.

2—Controlling Liquid Level—Five different methods of liquid level control are completely described in Publication 2939. Complete descriptions of the operation and advantages of each type simplify proper selection from tabulated data that includes operating characteristics and list prices. Cochrane Corp.

3—Potentiometer—Pyrometer—A new 6-pp. bulletin illustrates and describes a new portable potentiometer-pyrometer and covers application, operation, and specifications. J-B-T Instruments, Inc.

4—Draft Gage — Dwyer Transparent Draft Gages are described in Bulletin No. 31 issued by F. W. Dwyer Mfg. Co., Chicago, Ill. Made of a crystal clear plastic, these gages are machined from a solid block, giving them strength as well as clarity. New listings are included as well as more complete data on the applications and specifications.

5—Instruments—A new 16-page illustrated catalog, section 43-205, of rectangular case switchboard instruments, types HA, HX, HY, and HZ explains features such as high overload capacity, wide frequency tolerance, low burden, uniform case size and numerous others. Construction and operating principles are fully described. Different types are illustrated, including the triplex instruments. Complete dimension, mechanical, and electrical data are given. Westinghouse Electric & Mfg. Co.

6—Gage—Supplement Bulletin 22 illustrates and describes the Ellison Straight-line Diafram Gage. Ellison Draft Gage Co.

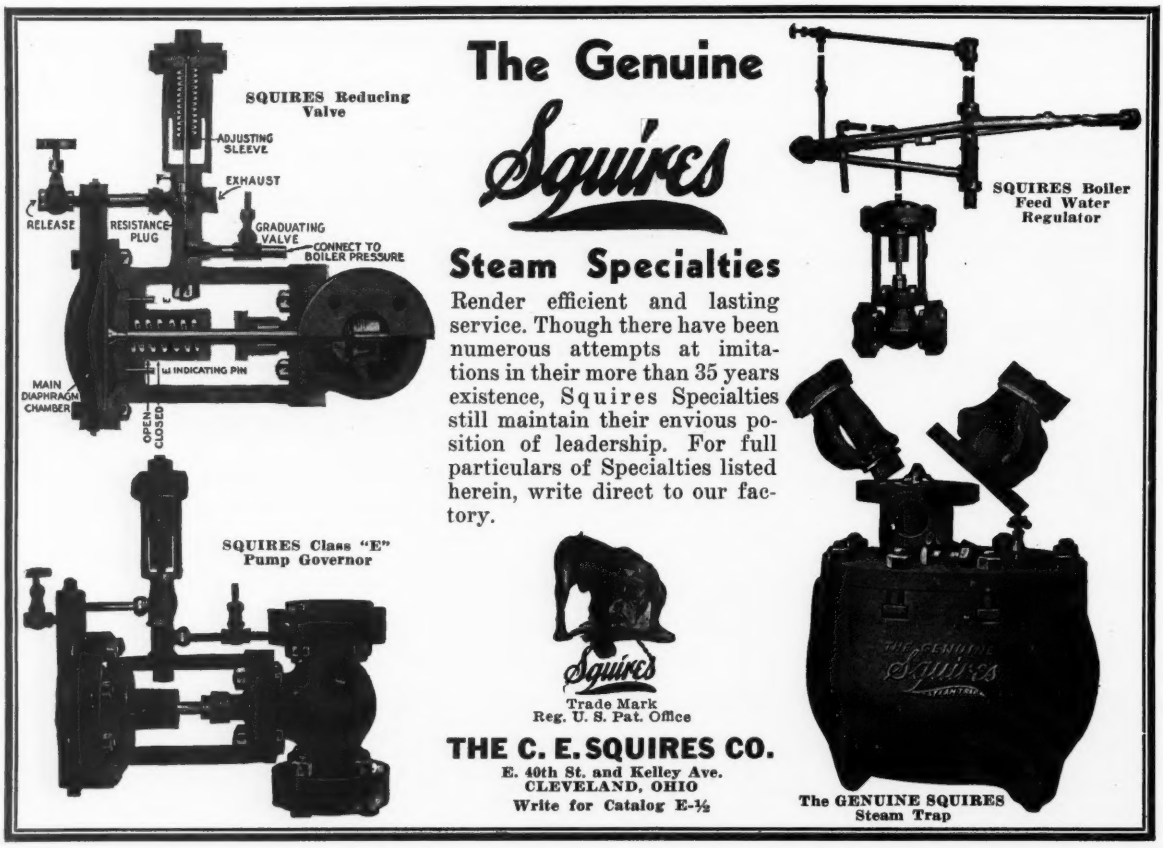
7—Indicator — Bulletin 400 on the Knopp Phase Sequence Indicator gives considerable detail concerning the construction of this instrument and also its numerous applications. Electrical Facilities, Inc.

Stokers and Fans

8—Stoker—A new 16-page catalog, No. MR-4, giving details of the most recent design of C-E multiple-retort stoker, type MRO, describes the engineering background, operation and principal features of the stoker, and contains 31 illustrations compising photographs, cutaway sections, diagrams and drawings of typical installations. Combustion Engineering Co., Inc.

9—Fans — Capacity Tables for Type ME Centrifugal fans—both slow speed and high speed wheels are given in the Company's conventional 8½ x 11-in. sectional catalog form. These publications conform to the program of industry standardization for sizes and construction as adopted by the National Association of Fan Manufacturers at its annual meeting in Chicago, April 11, 1940. The New York Blower Co.

10—Single-Stage Blower—Bulletin, B-6048, on Single-Stage Turbo-Blowers gives the advantages of turbo-blowers, their method of operation and characteristics. It illustrates and describes various single-stage motor and mechanically driven blowers. Several pages are devoted to blower accessories. Allis-Chalmers Mfg. Co.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11—Hot Process Water Softeners—A 32-page catalog under this title the most comprehensive treatise on hot lime soda softening ever published. It describes the five types of deaerating and non-deaerating heaters and explains the principle and function of each unit part. Filters, both vertical and horizontal, and the electro chemical feed complete the picture. A brief section on the chemistry of water softening and corrective treatments is also included. The Permutit Co.

12—Boiler Feedwater Regulators—Bulletin 429 containing 16 pp. describes the Copes Flowmatic Regulator and is illustrated with operating diagrams, performance charts and installation photographs. Northern Equipment Co.

13—Proportional Feed Diagrams—Three Proportional Feed Diagrams which show, respectively, how to feed boiler water treating chemicals against boiler pressure, how to feed two or more boilers from a single-end pump and how to feed two boilers, individually or together, from a double-end pump are now ready for distribution.

14—Industrial Waters in Canada, by Harald A. Leverin, was recently published by the Bureau of Mines, Department of Mines and Resources, Ottawa, Canada, as Interim Report No. 5. This is a mimeographed report of 33 pp., giving the details, analysis and characteristics of 714 samples of surface and civic water supplies covering practically the entire Dominion of Canada.

15—Deaerating Heater—This 12-pp. illustrated bulletin, No. 2357 describes and illustrates the Permutit deaerating heater for removing oxygen and free CO_2 from water. Illustrations show how the heater may be used in conjunction with hot lime soda softeners, zeolite softeners, Zeo-Karb H and Na or Zeo-Karb Na plus sulfuric acid treatment. The Permutit Co.

Power Transmission

16—Speed Increasers—A new 24-pp. illustrated booklet 3650 describes the complete line of Type SU speed increasers which are designed especially to supply output speeds in excess of that which can be directly obtained with economy and safety from ordinary prime movers. The booklet presents application data, construction features, tables and sketches giving complete capacity and dimension information. Westinghouse Electric & Mfg. Co.

17—Texrope Drive—A completely revised 16-page edition of the Texrope Drive Bulletin No. B-6051-A contains facts and data essential in estimating costs, types and sizes of v-belt drive equipment by specifiers and buyers in every industry. Besides including the latest revised horsepower ratings, it contains more information of Texrope belts, Texsteel, Texdrive and regular cast iron sheaves. Complete information is also carried on cast iron adjustable and Vari-Pitch sheaves. Dimensions, horsepowers and speed range table are shown for eleven sizes of Vari-Pitch Speed Changers ranging up to 75 hp. Allis-Chalmers Mfg. Co.

18—Belt Costs—Cost Finding Record for Conveyor Belts is the title of a new booklet which contains 12 record sheets of two pages each, sufficient to keep a complete record on 12 conveyor belts for six years, with tonnage records for each month on each belt. The sheets provide listing of all essential information on the belt, including make, brand, duck weight, length, width, number of plies, type of joint, lacings used, best previous record of belt on the installation, date received and installed, date removed, time in use, invoiced cost, cost of repairs, total cost, total tonnage handled, and the cost per ton. Space is also provided for a maintenance record, a description of the layout, pulleys, idlers and every other important factor that goes into a conveyor belting problem. The B. F. Goodrich Co.

Pumps and Traps

19—Oil Pump—De Laval-IMO Oil Pumps, designed particularly for handling various grades of fuel oils, heavy crude oils, lubricating oils and hydraulic oils in capacities above 30 gal. per minute and for pressures up to 500 lb. per sq. in., are described and illustrated in catalog L-32-A now being distributed by the De Laval Steam Turbine Co.

20—Trap—The Cochrane Discharger is illustrated and described in a new catalog, Publication 2935, which contains capacity table, dimensional data and prices, and complete operation information. Cochrane Corp.

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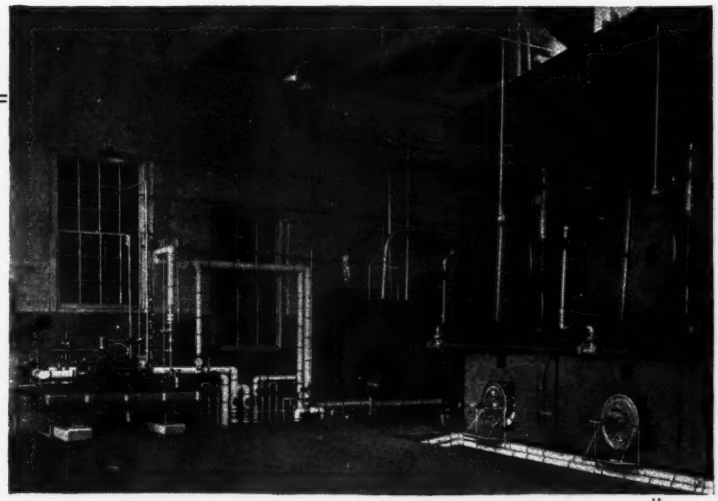

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21—Pumps—The new sewage plant of the City of Ypsilanti, Mich., a primary sewage treatment works, including clariflocculator and clarifier operated in parallel, is described in an article which has been reprinted and is being distributed by the De Laval Steam Turbine Co.

22—Pumps—Automatic priming systems for centrifugal pumps operated singly or in groups are described in a leaflet issued by the De Laval Steam Turbine Co.

Electrical Equipment

23—Electrical Control—Publication No. 159, eight pages, describes Polarized Field Frequency automatic control for synchronized motors manufactured by Electric Machinery Mfg. Co. Function and construction of the control parts are explained and connections of a typical control illustrated.

24—Capacitors—G. E. Pyranol Capacitors are described in GEL-619 issued by General Electric Co. This bulletin shows savings effected in various plants by the use of capacitors.

25—Circuit Breakers—Catalog 1230, an 8-page bulletin describes new low voltage metal-enclosed air circuit breaker switch-gear manufactured by Roller-Smith Co.

26—Electrodes — A new wall chart measuring 36 in. by 24 in. lists a number of different electrodes giving application, properties and procedure. The Lincoln Electric Co.

Miscellaneous

27—Lead Goods—A 4-pp. card contains information regarding lead products which should be of extreme value in estimating, including charts showing weights per square foot of sheet lead, lead pipe and price lists on lead fittings. Alpha Metal & Rolling Mills, Inc.

28—Sewage Treatment—A 20-page bulletin No. 23-B12 illustrates and describes equipment used in sewage treatment and water works plants. Volume-pressure curves and operating characteristics of both positive displacement and centrifugal type blowers are shown. The economical use of gas from the sludge digestor tanks in gas engines driving aeration blowers is described in detail. Roots-Connersville Blower Corp.

29—Dust Collector — Circular No. 32 illustrates and describes the New American High Efficiency Cyclone Dust Collector. The American Foundry Equipment Co.

30—Dust Collector—A new type Thermix Tubular Dust Collector is illustrated and described in a new catalog No. 108 covering operating principles and construction details. Prat-Daniel Corp.

31—Mask—A new bulletin illustrates and describes the M. S. A. Ammonia Mask to which the All-Vision Facepiece has been added as standard equipment. Mine Safety Appliance Co.

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New Engineering Books

Diesel Monitor. By Julius Rosbloom. Published by the Diesel Engineering Institute, 576 Newark Ave., Jersey City, N. J. Size 5½ by 7½ in.; flexible fabricoid cover; 512 pages. Price $5.00.

This book, intended primarily for the Diesel operator, is of a practical nature, dealing with the operation, construction, adjustment, maintenance and repair of the Diesel engine and its auxiliary equipment. Approximately half of the book is in questions and answers form, covering the type of material and the subject matter which must be known by men applying for licenses in the marine and stationary fields.

Handbook of English in Engineering Usage. By A. C. Howell. Published by John Wiley & Sons, Inc., New York, N. Y. Second Edition, size 5 by 7½ in. 433 pp. Cloth bound. Price $2.50.

This book is written as a guide to engineers to enable them to express themselves clearly, accurately and concisely. This being just as important as the other branches of the engineering profession, the engineer should master the English language so that in speaking and writing he will be able to express himself clearly to his listeners or readers. This book teaches the reader to express himself without a constant use of technical Latin or Greek derivatives which in many instances are not entirely understood. The foreword is a letter written by C. J. Kettering of the General Motors Corp. which states in part: "The student of engineering who masters English can do much to advance his chosen profession, not only by presenting his own findings to his fellow engineers but also by presenting himself as an ambassador of science to the public."

The Hoisting and Portable Engineer. By David J. Newman, Sr. Published by H. & P. Publishing Co., Station H, Buffalo, N. Y. Size 5 by 8 in.; 48 pages; paper bound. Price $2.00.

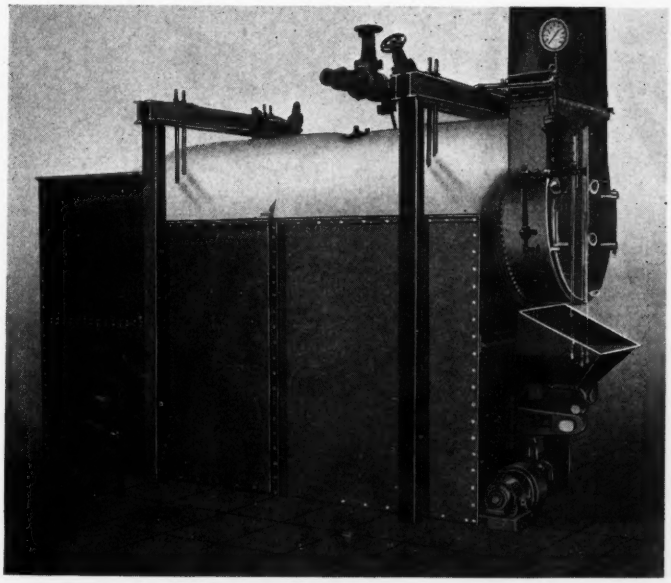
The construction engineering field is a broad and even changing one requiring knowledge of the operation, care and maintenance of many power driven machines. This booklet consisting of two hundred questions and answers, is intended as a practical guide for operating engineers, reference for supervisors and as a practical text for those preparing for an examination. To increase its usefulness the questions are divided into nine sections covering boilers, brakes, cranes, derricks, engines, pile drivers, platform hoists, signals, and wire rope. Inasmuch as the lives of himself, fellow workers and often the general public depends upon the skill and experience of the hoisting and portable engineer emphasis has been placed on safety in a large number of the questions.

Lessons in Arc Welding—Published by The Lincoln Electric Co., Cleveland, Ohio. 144 pages. 6 x 9 in. Price is 50 cents per copy, postage prepaid anywhere in U. S. A. Elsewhere 75 cents.

This book will be found helpful not only by beginners learning to arc weld but also by experienced welders desiring the comprehensive practical information contained in the volume, also by welding officials, such as supervisors, foremen and instructors, and others seeking a ready reference to fundamental information on arc welding and a guide to its proper application. It is a series of 51 lessons, based upon experiences of Arthur Madson, instructor of The Lincoln Arc Welding School, presenting in concise manner fundamental facts of welding, knowledge of which will enable the welder to utilize the welding process successfully and economically.

Beginning with an introduction giving preliminary instructions to the welder, nineteen lessons comprise the instruction in use of unshielded arc electrodes. There are 9 lessons on use of shielded arc electrodes. Instruction in use of electrodes for particular joints and metals consists of 15 lessons. Eight lessons comprise instruction on hard facing.

Text explanations are graphically supplemented by line drawings and photos for ready understanding. A valuable feature of the book is the questions on each of the lessons, enabling the student to check his knowledge.



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Power Plant Construction News

Calif., San Diego—Ryan Aeronautical Co., 2930 Pacific Avenue, plans installation of electric power equipment in new one-story addition to aircraft-manufacturing plant. Entire project is reported to cost close to $100,000. Proposed to begin work soon.

Conn., East Hartford — Hamilton Standard Propeller Division, United Aircraft Corporation, plans installation of electric power equipment in new one-story addition, about 70 x 600 ft. Entire project will cost over $350,000. Proposed to begin work soon. Albert Kahn, Inc., New Center Building, Detroit, Mich., is architect and engineer.

Conn., Stamford — Norma-Hoffman Bearings Corporation, Stamford, manufacturer of ball and roller bearings, has approved plans for new boiler house at plant. Work will be carried out in connection with a one-story factory addition, 60 x 120 ft.; electric power equipment will be installed in latter structure. Entire project will cost over $75,000. Fletcher-Thompson, Inc., 1336 Fairfield Avenue, Bridgeport, Conn., is architect and engineer.

Ill., Chicago—Bastian-Blessing Co., 240 East Ontario Street, manufacturer of soda fountains, gas apparatus, etc., plans installation of electric power equipment in new one-story plant on 13-acre tract of land at Peterson and Rogers Avenues, recently acquired. A complete air-conditioning system will be installed. Proposed to begin construction early in fall. Entire project is reported to cost close to $500,000.

Ill., Chicago—Continental Can Co., 2633 West Grand Avenue, plans installation of electric power equipment in new four-story and basement plant addition at 3800 South Ashland Avenue, 150 x 200 ft. Work is scheduled to begin at once. Entire project will cost over $200,000. W. A. Taylor, 4622 West Grand Avenue, is company architect.

Iowa, Hampton—Federated Co-operative Power Association, Hampton, Arthur Olliphant, superintendent, has plans under way for expansion in power plant, with installation of additional equipment for increased capacity. Fund of $180,000 has been arranged through Federal aid for project. Stanley Engineering Co., Muscatine, Iowa, is consulting engineer.

Md., Vienna—Eastern Shore Public Service Co., Salisbury, Md., has plans maturing for new addition to steam-electric power plant, 100 x 200 ft., at Vienna, to include installation of new turbine-generator unit and accessories, boiler and auxiliary equipment. Cost reported over $1,000,000. Utilities Management Corporation, Reading, Pa., is consulting engineer.

Mich., Bay City—Dow Chemical Co., Midland, Mich., plans installation of electric power equipment in new additions to Dowmetal plant at Bay City, consisting of four one-story extensions. Proposed to begin work on initial structure at early date, with others to follow in succession. Entire project will cost over $750,000.

Mich., East Lansing—State Board of Agriculture, Capitol Building, Lansing, has plans maturing for addition to power plant at Michigan State College, East Lansing, including improvements in present station. New boiler units and other equipment will be installed for increased capacity. Cost reported over $300,000. Work is scheduled to begin in near future.

Mich., Pontiac—Yellow Truck & Coach Mfg. Co., plans installation of electric power equipment in new one-story addition, 120 x 500 ft., to taxi-cab-manufacturing plant. Entire project will cost over $200,000. Albert Kahn, Inc., New Center Building, Detroit, Mich., is architect and engineer.

Minn., Owatona — Public Utility Commission, W. J. McDonnell, secretary, will receive bids until Sept. 10 for steam-generating unit and auxiliary equipment for installation in municipal power plant. Pillsbury Engineering Co., 1200 Second Avenue South, Minneapolis, Minn., is consulting engineer.

Minn., Rush City—City Council is arranging immediate call for bids for new municipal power plant, including Diesel engine-generator unit and auxiliary equipment. Cost estimated about $100,000. Ralph D. Thomas & Asso-

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ciates, 1200 Second Avenue South, Minneapolis, Minn., are consulting engineers.

N. J., New Brunswick—Carter Products, Inc., 53 Park Place, New York, N. Y., plans installation of electric power equipment in new one-story pharmaceutical products-manufacturing plant on tract of land in North Brunswick Township, near New Brunswick, recently acquired. Initial unit will total about 100,000 sq. ft. of floor space. A boiler house is planned. Entire project will cost about $500,000. Albert Kahn, Inc., New Center Building, Detroit, Mich., is architect and engineer.

Ohio, Canton—Republic Steel Corporation, Republic Building, Cleveland, plans installation of electric power equipment in connection with expansion at mill at Canton. Two 50-ton capacity electric furnace units and accessories will be installed. Entire project is reported to cost over $500,000.

Ohio, Oberlin—Village Council has preliminary plans under consideration for expansion in municipal power plant, including installation of equipment for increased capacity, for use primarily at Obelin College, where new building will be erected. Cost estimated close to $70,000.

Ohio, Paulding—City Council has plans nearing completion for expansion in municipal power and waterworks station. Bids for generator unit and auxiliary equipment are scheduled to be asked soon.

Ohio, Wooster—Steel Storage File Co., 2216 West Sixty-third Street, Cleveland, Ohio, plans installation of electric power equipment in new one-story steel file-manufacturing works, 80 x 800 ft., on East Bowman Street, Wooster, where site has been acquired. A boiler house will be built, with stoker-fired boiler and accessories, for heating service. Entire project is reported to cost over $175,000. Company proposes to remove present plant to new location.

S. C., Parr—South Carolina Electric & Gas Co., Columbia, S. C., has approved plans for expansion and improvements in power plant at Parr Shoals, including installation of equipment for increased capacity. Cost reported over $500,000. This is part of a $1,200,000 extension and improvement program now under way, including transmission and distributing lines, power substations and other structures.

S. D., Yankton—Northwestern Public Service Co., Huron, S. D., will soon begin extensions and improvements in power plant at Yankton, to include installation of new 1400-hp. engine-generator unit and complete auxiliary equipment.

Texas, College Station—Board of Directors, Texas Agriculture and Mechanical College, plans new steam-electric power plant for service at institution. Cost estimated over $260,000. Proposed to carry out project in near future.

Texas, Corpus Christi—Central Power & Light Co., San Antonio, Tex., has plans under way for new addition to steam-electric power plant at Corpus Christi, including installation of new 15,000-kw. turbine-generator unit, boiler and auxiliary equipment. Proposed to begin work soon. Sargent & Lundy, Inc., 140 South Dearborn Street, Chicago, Ill., is consulting engineer.

Texas, Garrison—City Council plans extensions and improvements in municipal power plant, including installation of equipment. Also will make additions in electrical distributing system. Cost estimated about $40,000. Freese & Nichols, Capps Building, Fort Worth, Tex., are consulting engineers.

Texas, Houston—John Deere Plow Co., Moline, Ill., subsidiary of Deere & Co., Moline, plans installation of electric power equipment in new three-story agricultural implement-manufacturing plant on Navigation Boulevard, Houston, where site has been selected. Entire project will cost over $150,000. David M. Duller, Second National Bank Building. Houston, is architect. Houston branch of company is at 2107 Walker Street.

Va., Radford—Burlington Mills Co., plans installation of electric power equipment in new one-story addition, 165 x 200 ft., to rayon mill, on which superstructure will begin soon. Entire project is reported to cost over $125,000. Main offices of company are at Burlington, N. C.

Wis., Beaver Dam—Malleable Iron Range Co., Beaver Dam, plans installation of power equipment in new two-story addition, 100 x 200 ft., to stove and range-manufacturing plant. Conveying and mechanical-handling apparatus also will be required. Entire project is reported to cost over $75,000.

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COALS, STOKER, GAS SCREEN
Chesapeake & Ohio Lines
General Coal Company

COCKS, AIR AND STEAM
Crane Co.
Dart Mfg. Company, E. M.
Fairbanks Company, The
Lunkenheimer Co., The
Nicholson & Co., W. H.
Williams Valve Co., The D. T.

COILS & BENDS, PIPE
Badger & Sons Co., E. B.

COMBUSTION CONTROL SYSTEMS
Bailey Meter Company
Cash Company, A. W.
Engineer Co., The
Hagan Corporation
Hays Corporation, The
Republic Flow Meters Co.

COMBUSTION RECORDERS
Brown Instrument Co., The
Hays Corporation, The
Permutit Co., The

COMPOUND, PIPE JOINT
Smooth-On Mfg. Company

CONDENSERS
Allis-Chalmers Mfg. Co.
Elliott Company
Foster Wheeler Corporation
Worthington Pump & Machy. Corp.

CONTROL EQUIPMENT, ELECTRICAL
Cutler-Hammer, Inc.
General Electric Company

CONTROLLERS, LIQUID LEVEL
Cash Company, A. W.
Foster Engrg. Co.
Johnson Corp., The
Northern Equipment Co.

CONVEYORS AND ELEVATORS FOR COAL AND ASH HANDLING
Link-Belt Company

COOLING SYSTEMS, NOZZLES AND PONDS
American Blower Corp.
Badger & Sons Co., E. B.
Buffalo Forge Co.
Foster Wheeler Corporation
Pritchard & Co., J. F.
Yarnall-Waring Company

COOLING TOWERS
Pritchard & Co., J. F.

COPPER PIPING
Scovill Mfg. Co.

COUPLINGS, FLEXIBLE
American Blower Corp.
Morse Chain Co.
Nicholson & Co., W. H.
Terry Steam Turbine Co., The

COUPLINGS, UNION
Dart Mfg. Co., E. M.

Do Away with Dangerous
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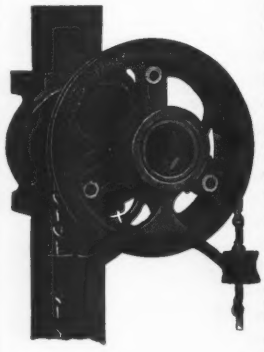

Stop climbing ladders to open and close those "high-up" valves. Equip them with Babbitt Sprocket Rims and you can control them quickly and safely from the floor. Babbitt Rims are easily attached and low in cost. They show real savings in time and steam—help guard against accidents. Now is the time to fit your overhead valves with Babbitt Rims. Write today for further information.

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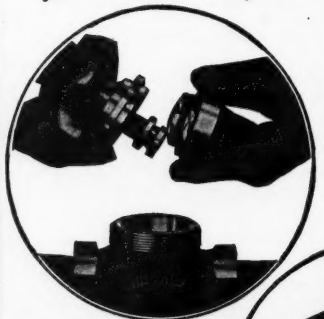

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Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact its absorption is less than 1 per cent. . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.

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